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ABSTRACT

This document consists of extracts from "Numeracy in Papua New Guinea: An Investigation with Particular Reference to the Relationship between Number Skill Teaching and the Use of the Calculator," a doctoral thesis submitted to the Loughborough University of Technology in April 1982. The material is made up of chapters and parts of chapters, including: (1) Introduction and Background to Papua New Guinea; (3) Adult Numeracy With the Calculator in Papua New Guinea; (4) The Use of the Calculator in Full-Time Education in Papua New Guinea; (6) Rationale and Critique; (7) Summary and Conclusions; and (7) Appendix. The original thesis was the result of 4 years of work in Papua New Guinea. It is noted that the Department of Commerce had identified poor number skills as a major factor restricting business development. Calculators were quickly viewed as the route to the only possible solution. A government grant enabled the potential for general adult numeracy to also be studied. Materials were prepared and the reactions of village people to calculator-oriented instruction was tested. It is felt calculators represent a possible means of overcoming the lack of number skills in individuals, nations, and disadvantaged groups anywhere in the world. (MP)

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THE HAND-HELD CALCULATOR
IN A THIRD-WORLD COUNTRY

ALLEN EDWARDS

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THE HAND-HELD CALCULATOR IN A THIRD-WORLD COUNTRY

Consisting of Extracts from "Numeracy in Papua New Guinea: An Investigation with Particular Reference to the Relationship between Number Skill Teaching and the Use of the Calculator", a Doctoral thesis submitted to the Loughborough University of Technology in April 1982, by Allen Edwards

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- not included in original thesis.

FOREWORD

The thesis "Numeracy in Papua New Guinea: an investigation with particular reference to the relationship between number skill teaching and the use of the calculator", was the result of four years work in Papua New Guinea (PNG) from 1978 to 1982.

The first two of these years were spent by the author setting up a Mathematics Education Centre at the PNG University of Technology in Lae. Here the main concern turned out to be to do something about the poor number skills at all levels throughout the country. This led to a desire to help ordinary village adults many of whom did not know their numbers.

Meanwhile the Department of Commerce had identified poor number skills as a major factor restricting business development. In particular there were large numbers of trade store keepers in the country who could do little more than add simple numbers together. During 1980-1982 the Department engaged the author to try to solve this problem.

It quickly became clear that the only possible solution lay in the use of the calculator. This had just became a practical possibility thanks to the invention of the Liquid Crystal Display which meant that the batteries for the calculators would never run out.

A government grant enabled the potential for general adult numeracy to be studied as well. The author and his wife were thus able to prepare materials and test the reactions of village people to this teaching. Eighteen tours were carried out over

15 months and detailed reports of these are included in the Appendix to the thesis. References to these "Adult Numeracy Reports," (ANR 1, ANR 2 etc) occur frequently in the extracts that follow.

The thesis itself is too long to reproduce in full and contains an analysis of the number-skill teaching in the schools which is not particularly relevant to the use of the calculator. It is hoped therefore that the extracts given here will provide a reasonably coherent account of the ongoing work of introducing the calculator to ordinary people in Papua New Guinea.

Cheap hand-held calculators have only been available for less than a decade. They are already comparable in price to a text book and will no doubt become ever cheaper in the coming years. They represent a possible means of overcoming the lack of number skills in individuals, in nations and in disadvantaged groups anywhere in the world.

1.2.2 THE CULTURAL BACKGROUND TODAY

The most noticeable feature of the cultural background in Papua New Guinea† is the immense number of independent languages, about 700, in a population of around 3 million. "Almost half the world's languages are on this island". [2, p.25]. The official languages are English, (Melanesian) Pidgin and Motu. Motu is only spoken in Papua, Pidgin is practically universal apart from a few areas where a single vernacular happens to be spoken by many people (eg. Huli in the Southern Highlands, see 3.4.1). Most expatriates learn enough Pidgin for basic needs. All formal education is in English.

Along with these 700 languages there used to be an estimated 250 different counting systems. These were of four main types [3, p 6]. About 12% were of Type I which is a "body parts tally system". When the parts of one man's body have been counted another man is required if the counting is to continue. About 15% belonged to Type II: in these, sticks or groups of commodities are used to form a 2, 3, 4 or 5 base system. About 40% were of Type III: these are true counting systems but most have mixed bases using 5 and 20 where for example the number 56 would be represented by 2 twenties, 3 fives and 1 one, or 2 men, 3 hands and a 1. There are usually only 4 discrete number words. The remaining 32% were probably of Polynesian origin and have a genuinely abstract concept of number. They use base 10. Some societies having these may still use a Type I system for special purposes.

The situation described is complex: but there is one simple fact about them all. "Virtually all Papua New Guineans are abandoning their traditional counting systems in favour of the decimal system of counting in English or Pidgin" [3, p 10]

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† Strangers find the name a bit of a tongue-twister. It comes more easily if you emphasise the first syllables "Par -" and "Guin -". The -Pua then slips in without too much trouble

Traditional methods of measurement in PNG have not been studied to the same extent but "there does seem to be a dearth of standardised units for measuring things" and "This doesn't mean that people don't measure things but rather that the systems for doing so are informal" [3, p 14].

By contrast an African culture such as that of the Kpelle of Liberia has basic measurements involving length, time, volume and money for which complex systems are available [4, p 62]. If only in order to express appreciation of the achievements of the older culture it would be wholly admirable to bridge the gap between traditional numbering systems and those of the West. Unfortunately in PNG the option is hardly practicable. The variety, the informality and the rapid abandonment of such traditional counting systems as exist combine to make it difficult in general even to attempt to relate western mathematical teaching to the traditional culture. Traditional counting systems can and will it is hoped continue to be used for traditional customs by the 85% or so of the population who live in rural areas and still follow a more or less traditional way of life. Once these people step beyond the boundaries of their own village however, perhaps only going as far as the next village, they need to communicate with others in some system other than their own. [5]

In such circumstances any teaching provided in the country must be related, not to the traditional but to the national system. In the case of numbers this simply means the "western" system.

1.5 NOTE ON COMMUNICATIONS IN PAPUA NEW GUINEA

The problems of communication in a country where the aeroplane is a normal means of travel because of the lack of roads have not been sufficiently stressed in this "Background to PNG".

Perhaps it is sufficient to quote an earlier paper by the author [6] in which he says: "The service which even a dedicated (schools) inspector can give is in any case limited when, typically, he has 18 schools to visit, five of which require a total of 27 hours walking, five can only be reached by air and his main centre is a 3 hour drive from his headquarters." [47]

CHAPTER 3

ADULT NUMERACY WITH THE CALCULATOR IN PAPUA NEW GUINEA

3.1 THE NUMERACY PROJECT

3.1.1 THE TASK

As indicated in 1.4.1 the author's concern for grass-roots education had led him and his wife to conduct a course in Lae for the Department of Commerce in 1979.[18]. Unknown to himself this coincided with a growing realisation within the Department of Commerce that lack of number skills was a very serious problem for businessmen in Papua New Guinea.†

It was the job of Business Development Officers to train businessmen to be self-reliant. Without teaching them number skills this was virtually impossible, and Business Development Officers (BDO's) were not trained to teach arithmetic. The consequence was that instead of teaching many businessmen to be self-reliant the BDO was in effect only making a few of them dependent on him.

The problem was noted by Mary Dickie, then Staff Development Officer in the Department of Commerce. She had seen a report of the author's course at Lae. As a result of further discussion he was offered a post at Laloki College. This was the institution used by the Department of Commerce to train BDO's but the author's main responsibility would be to try to solve this problem of inadequate numerical skills in businessmen.

The author had had no previous experience in commerce but the task was closely related to his concern for adult numeracy. He was therefore happy to accept this appointment in March 1980 although at this stage he had little idea of either the problems or a possible solution to them. To give his task a name the "Numeracy Project" was created and he was nominated as its Director.

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† Acknowledgement should also be made of the self-assignment of Tony Wrightson a Lecturer at Goroka Teachers College who spent 3 months living in the Morobe Highlands to help trade storekeepers in the area. He experimented with the use of calculators supplied by the author while he was still at the MEC [59]

3.1.2 THE PROBLEM

Some businessmen could add a column of numbers correctly, few could subtract and fewer still could multiply or divide.

Teaching adults to subtract takes a long time. The Author's wife, Mary, had spent a whole afternoon with one particular businesswoman on that course in Lae the previous year trying to do this. No matter how well motivated a student may be the subtraction algorithm requires much practice before it can be remembered. As for multiplying and dividing, this is virtually impossible without learning or making frequent reference to multiplication tables and even then the algorithms are complex.

The Department of Commerce had in fact produced a ready reckoner [60] that converted price per pack into price per unit given the percentage markup required, but this was a two-part book of 100 and 24 pages. It was not easy to understand with its use of ranges for the price per pack. Part 2 of the Ready Reckoner for example gave the results of dividing 'cost per pack' by the number in the pack. On page 23 one found that if the cost per pack was K223.39 - 225.16 then the cost each was K1.26†. These ready reckoners were still in demand by those who had been taught to use them and knew no other way of pricing their goods, but they did not appear a good way to develop the work.

3.1.3 THE ELECTRONIC CALCULATOR

The only alternative to these methods was to use the electronic calculator, which after all is the normal method used everywhere in the Western world. The Papua New Guinean is well known for his readiness to accept modern technology so there were really only four objections to introducing the calculator:

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† As stated in 1.1.3 the Kina (K) is worth 100 toea (t) or about £0.70.

(1) its price, generally K15-K30 in the shops

(2) the likelihood of its going wrong

(3) the battery running down

(4) the difficulty of teaching without first standardising the calculators

While at Lae in 1978-1979 the author had discovered the very large mark-up (often 100%-200%) being applied to calculators by wholesalers and retailers and he had arranged for the Mathematics Education Centre to import and sell a cheap basic model at K8 each. Unfortunately these had a high failure rate of 5%-10% and the 50t battery ran down in a nominal 100 hours, particularly if one forgot to switch it off. It would have been irresponsible to sell these to village stores where they would almost inevitably have become useless status symbols. In enquiring about a substitute for this model in 1980 however it was discovered that the Liquid Crystal Display calculator was now being mass produced and could be imported for little more than the price we had been paying for the LED variety. These had a nominal 10 000 hours battery life and an "auto power off". I also found them very reliable with a failure rate of under 1%.

From July 1980 to July 1981 the Laloki College Canteen (operating on behalf of the Numeracy Project) sold 2820 Sharps EL8158 calculators at an average price (including postage) of K7.80. It was then explained to the manufacturers what we were trying to do for Papua New Guinea and a reduction in price was suggested. They discontinued the EL8158, but offered us the EL220 which was smaller but otherwise almost the same, at a discount of 22%. From August to December 1981 we sold 1470 of these at an average price of K5.80 again with a failure rate of well under 1%. The availability and price of these calculators were sufficient to justify treating them as standard and only providing teaching materials for them. All the objections listed above were thus overcome.

3.1.4 ADULT NUMERACY

The advent of the LCD calculator thus heralded a new possibility for Papua New Guineans to try to overcome the lack of number skills inherited from the past. During 1978 and 1979 I had come to the conclusion that my aim should be nothing less than "making PNG numerate". (see 1.1.3) Very little research however had been done on the numeracy of adult Papua New Guineans, compared with the immense effort that had been put into anthropological and linguistic research. The only relevant document I could find was the report "Youth in Their Villages" edited by Sheldon G Weeks of the Educational Research Unit of the University of Papua New Guinea.[61] This however made no attempt at a nationwide survey, being concerned with the extent to which reading, writing and arithmetic skills were retained by young people after leaving school and returning to their villages. It covered only six specific villages.

In the absence of any national figures or the funds to carry out a proper survey to ascertain them, I decided to produce the best evidence I had available. This consisted of the memories of the Business Development trainees who were currently at the Laloki College where I was working. The major bias in this survey would be to limit it to the villages that had produced people who had ultimately entered the business field. The decision to come to Laloki had however, in the case of these particular students often been a marginal one: at this time (in contrast to the 1982 entry for example) most of those in the College had only come because they had not been given their first choice for post-secondary education. Nevertheless the result of this survey must be read with this possible bias is mind.

In the investigation "Arithmetic Skills of Adults in Papua New Guinea: A subjective Enquiry", in September 1980 [62] information was obtained for 79 villages about one third having under 50 adults and one third having over 100 adults in them. The respondents estimated only 35% of the adults could add or subtract numbers up to 9 in their heads. Given pencil and paper it was thought that 26% could add together 5 prices of goods in a store, 32% could work out change, 16% could multiply or divide.

By contrast these 79 villages contained some 335 trade stores, an average of one store to 38 adults. It was not surprising that the respondents considered that only 15% of these stores were run well, one of the reasons given in 93% of the cases being bad management. By contrast, only 43% of the respondents thought that "too much competition" was the reason.

This bleak picture of the potential for business life in villages was no surprise to the Department of Commerce and they were willing to support my suggestion that lack of number skills in the community itself was one of the major impediments to the development of business. A proposal was therefore put up to the Village Development Council that a preliminary survey should be carried out into the feasibility of a nationwide Adult Numeracy Campaign. A grant of K3500 was received from the Prime Minister's Non-formal education sectoral fund to enable a survey to be carried out in five Provinces between October and December 1980.

The results of this survey were affirmative and a grant of K14,290 was provided for work on the experimental stage in 1981. The original concern for businessmen remained but there was now a reason to expand the work into the non-business field. The combination of these two concerns directed the activities of the project and therefore of the author, during the latter part of 1980 and the whole of 1981.

3.1.5 OBJECTIVES

The primary objectives of the Department of Commerce Numeracy Project were defined in September 1980 as:

1 To increase the level of numeracy amongst Papua New Guinean business people, business groups and the communities in which they exist ...

2 To reduce the requirement for business development officers and other extension workers to provide simple

support to businesses and income generating projects ...

To meet these objectives we needed to answer three inter-related questions:

What should they be taught?

When should they be taught?

How should they be taught?

In the course of fiteeen months from September 1980 to December 1981 we identified many different groups of people each needing to be taught different things in different ways.

At first it was by no means clear exactly who these target groups might be but looking back it has been possible to identify the following significant groups:

A Businessmen with simple but inadequate arithmetical skills

B Villagers who already know their numbers

C Village people who do not know their numbers

D Government officers and others who have already used a calculator but lack the skill to use it effectively or the confidence to teach others to use it

These four main target groups and the many sub-groups within them needed different answers to the questions "What to teach?" and "How to teach?" But all the work was relevant to the primary objectives set out above.

3.2 BUSINESSMEN WITH SIMPLE BUT INADEQUATE SKILLS

The Project's most obvious target group and those for whom it was originally set up were business people with some simple arithmetical skills but lacking those needed to run their businesses properly.

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had been running a similar, if not better, system since 1972 [64] so that the proposed course was unnecessary duplication. The course referred to however required a long intensive and residential training which few trade storekeepers would willingly contemplate. The Department had no hesitation in rejecting the suggestion that there was any unnecessary duplication.

Several of the field workers consulted suggested that few of their clients would be able to use the material proposed for Units TS4,5 or Bank reconciliations. Units 1 and 2 were warmly welcomed however: "The basic problem which a great deal of trade stores face is the inability of the person serving to give the correct change" (Southern Highlands). "I found great difficulty in explaining the idea of pricing and costing, due to the fact that the proprietor did not have an understanding of multiplication and division" (West Sepik). Doubts were expressed about the total reliance on the calculator implied by the course.

> "I would personally prefer traditional methods to be used so that the student would get a basic feel for numbers and not rely on a piece of machinery" (Southern Highlands).

> "I think any Arithmetic test should be subdivided between mental arithmetic and use of a calculator" (Development Bank).

> "The idea of calculators is a good idea however perhaps a basic course in its use should also be included as I know of very few persons at the village level who have ever seen one let alone used one" (Western Province).

> "I am not one hundred percent sure that a basic Numeracy Course should be based on the use of calculators ... I am more inclined to feel that the arithmetic principles should be taught and practised without a calculator and a separate section of the course 'Using a Calculator' be taught afterwards. If

> a calculator is to be used a very detailed explanation of its operation and lots and lots of practice will be necessary - again for my average trade store owner (referred to earlier as 'about Grade 6 standard'). Because of his lack of basic arithmetic knowledge and number sense he will get many wrong answers on his calculator. He will press 5 or more likely .5 for five toea, he will leave out the decimal point regularly and at first sight he will not know for example that 5.56324 means K5.56 (Several students selected from 200 nationwide applications for the Advanced Course at Laloki last November made these sort of mistakes)". (Milne Bay Province)

Early in June those responsible for training in the Department of Commerce met to assess these responses and to determine future policy. It was agreed that the first two units TS1 and TS2 should be tried out locally, that further material at a similar level should be written and that the name of the course should be changed to "Arithmetic for Business"(See 5.7).

3.2.2 A WIDENING EXPERIENCE

During the process of rewriting these materials the writer's knowledge of the scene was broadened by a number of experiences.

The Training Manager for Steamships Trading Company had found a problem when their cordial factory had tried to introduce a new form of invoice to facilitate "cash on delivery" by making allowances on the spot for returned empties. This involved multiplication which could be done with a Ready Reckoner, but it also required subtraction which the drivers found very hard.

To meet this need a self-paced course (see 5.5) was written and taught by the author and his wife. At first the aim was to combine mental and calculator skills, using the one to check the other. It became clear however that few employees would in practice ever undertake this checking process. So when a large proportion of the workers we had trained had suddenly to be replaced because of their involvement in a theft, the course for the new employees cut out the mental work and the use of the Ready Reckoner, going straight to the use of the calculator. Eighteen months later the same system was still in use, although calculators were now fixed to a heavy steel plate to make them less likely to be lost.

The author was also asked to assist with the Plantation Management Training Programme but although detailed instruction sheets were prepared they were probably found to be too complicated and too full of checking procedures to be generally acceptable (see 5.8). The Programme Director went on leave just at that point anyway.

At the Small Industries Research and Development Centre I was asked to advise on a variety of businesses where difficulty had been experienced in persuading the clients to keep their accounts. Here however non-mathematical problems intervened such as the failure of groups of weavers and carvers to buy or sell anything for more than a fortnight and the presence of book-keeping clerks employed by the Department who made it unnecessary for the potters to keep their own books.

A major decision was also make to do all future work in toea instead of Kina. The reasons were as follows:

(1) Decimals were not generally understood. The common practice of writing both K and t thus K3.52t made this lack of understanding obvious. It was also not generally known that there were 100 toea in one Kina

(2) In the Steamships course 0.05 and 0.50 had been frequently confused

(3) The detailed instructions required to handle results such as 3.5 on the calculator had been difficult to write convincingly

(4) Many commercially used pro formas provided separate columns for kina and toea, making the decimal point unnecessary

(5) The fact that inserting a decimal point was generally a less efficient means of using the calculator had also to be acknowledged (except where many items were in whole kina)

(6) A study of calculators used in large stores revealed the "Add mode" where amounts were entered in toea and the results given in kina

(7) When answers involved a large number of figures after the decimal point, as in division, it was easier to say "forget everything after the point" which you can do if you are working in toea, rather than "count two figures after the point and forget the rest" which was the version necessitated by working in Kina

The decision to work in toea was probably the most far reaching and also the most controversial one at this stage. No convincing arguments against it however have since been produced. Only at a later stage such as at Grade 10 or above, would it seem worthwhile to consider the possibility of using the decimal point to work in kina and providing the appropriate teaching for this.

On October 3o/31 1980 the new "Arithmetic for Business" (5.7) was first used in a genuinely rural trade storekeepers' course at Nipa in the Southern Highlands. (The full report is in Appendix 2, in ANR3). In fact only two units proved to be generally teachable, one on totalling and finding change and another using a Check Slip to find the current balance in a Cash Book with IN and OUT columns only. Indeed even these units were much too hard for some of the clients two of whom, Agen and Oreb, had to be taught separately by my wife while I took the majority. Agen could match the numbers 1, 2, 3, . . , 9 to numbers of objects but Oreb could not do this. Agen could count money in multiples of 10 toea and give change for K1 but Oreb could only do it with multiples of 20 toea. Each sold 6 items in their store, priced at 20t, 40t, 50t and 60t. Agen waited until he had K240.00 in his hand, then he paid

K40.00 for transport to Mendi and bought goods with the remainder. Both were successful trade store owners in their own way and no doubt employed wantoks[†] to help them but one wondered if they could ever be brought up to any reasonable standard of arithmetical competency.

3.2.3 FREQUENT MODIFICATIONS

From this point on material for teaching trade storekeepers, along with other adults, was produced on individual sheets, trialled, and frequently rewritten (see 5.10).

At one point finding the mark-up % given the cost and selling prices seemed a good introduction when visiting a trade store for the first time, but the direct approach of calculating the "correct" price was reverted to later. Finding the mark-up % was a longer and more mysterious process on the calculator.

On a visit to Mendi in April 1981 the Principal of the local United Church Pastor - Training College sought my advice on a technique he had developed for checking leakage (ie losses due to spoiling of goods, stealing etc) in the College trade store they were just setting up. With some modifications appropriate to the best use of a calculator this was to become a standard part of our material. It was an attempt to control effects on "wontokism" which is generally recognised as a major problem for business in this country because along with many laudable features it also involves giving away one's goods to one's friends.

3.2.4 THE BUSINESS ARITHMETIC WORKBOOK

In May 1981 Mary Dickie, now Assistant Secretary for Training, to whom I was responsible until her departure in October 1981, proposed the writing of a "Business Arithmetic Workbook". This would be used by Business Development Officers to teach their clients either on the job or in courses. She also suggested the preparation of cartoon strips to provide notes on specific processes which clients had to remember. The workbook would be incorporated in the Laloki College pre-service training for BDOs and would be "launched" for use in the Provinces at a Workshop for PFAs and FTOs in August. (see Appendix 2, ANR 11).

[†] "Wantoks" are people who speak the same language ("one talk"). In PNG with its 700 languages the word has thus come to mean "friend". The "wantok system" is basic to the culture: you serve your friends first and expect them to do this for you.

Before the end of the month six units had been prepared in Pidgin and printed in two colours from hand-written masters.([65]see 5.12) Just after it had been written we received a report from Jonathan Spector, the PFA (Provincial Financial Adviser) for Manus Province, on a very popular course he had conducted, also in Pidgin, using a modified version of materials I had written earlier. [66] A number of points he made were significant:

(1) The use of (CE) wherever possible instead of (C) was emphasised and this tallied with our own experience of the chaos that could be caused in a class by frequent use of the (C) key

(2) 1 (+) (=) (=) (=) ... was used as a method of counting stock. We introduced this but subsequently doubted whether it was really practical

(3) He found the freight as a percentage of the total cost of a delivery and used this in pricing the goods. We included this at once as one method of pricing but were never sure whether the gain in ease of calculation quite made up for the increased "magic" in the process for clients who had no real understanding of proportion

(4) Jonathan also introduced a method of calculating profit using the value of stock at Selling Price reduced by 10% to approximate to valuation at Cost Price. He thought this was the only method his clients would be able to use anyway, and he may well have been right. We adopted it but used a 15% instead of a 10% adjustment.

The new Business Arithmetic Workbook course was tried out at Menyamya (see Appendix 2, ANR 12) where most of the students were trade storekeepers. At first it was disappointing. The difference between using (CE) for a wrong entry and using (CE) when a sign had been omitted between two entries caused complications. The self-paced format meant that some of them worked ahead without waiting for oral explanations or reading the verbal ones in the text.

One client asked how to work out the cost of 11 tins of fish at 45t each which was easy, but this led immediately to bills involving two such purchases and the complication of including ⊕ followed by ⊗: basic calculators such as the EL220 normally carry out operations in the order in which they are given so 2 ⊕ 3 ⊗ 4 ⊜ gives 20 not 14. I decided to use the memory as a means of overcoming the problem, having noted that this was in effect the method used in some larger calculators with sub-totalling facilities.

My wife also found the great benefit that could accrue from using actual goods instead of pictures. The less able students particularly seemed to benefit from the additional realism. On subsequent courses the Workbooks were used as exercises rather than as self-paced units and most of the original difficulties disappeared, leaving a number of improvements to be incorporated in the next edition.

The new edition was to be in English and was the first of the Project's materials to have the benefit of professional lay-out and illustrations, thanks to Kirsten Karanfilovic of the ILO/UNDP Project for Small Scale Enterprises and Entrepreneurship in the South Pacific.

The main modifications made in this edition [65] were:

1 combining the two units on checking invoices and pricing goods without freight

2 adding a cheque account section including the use of a "Bank Book" and Reconciliation slip

3 Increasing the number of examples of the Leakage Check calculation and introducing Jonathan Spector's Profit and Loss method but referring/to it as "changes in Net Liquid Assets" to avoid criticism of an imprecise use of the term "profit"

4 The use of RCM twice to recall and clear the memory instead of OFF ON to clear it after using RCM once.

A copy of Unit 5 is included in Appendix 3 as a sample of the course.

It was agreed that memo sheets would be needed to remind clients of the processes they had learnt and it is hoped that such material may be produced in cartoon form in Pidgin by June 1982 with the help of an expert cartoonist, Bob Browne, as originally suggested.

A decision on translating the Workbook back into Pidgin was postponed. Relevant arguments were as follows:

1 The style is that of a self-paced course, addressed to the client. As such it includes precise instructions on what must be done and how. Pidgin is not a good language in which to give precise instructions. The result is likely to be long and clumsy.

2 In spite of the course being addressed "as to" a client it is not expected that many clients will be able to follow the instructions themselves. Even some highly educated students find self-paced materials difficult to use initially. The style is designed primarily to enable a teacher, such as a Business Development Officer, to give correct instruction to a client. Business Development Officers do not need to have the work translated into Pidgin, they can translate it themselves when they are giving the instructions, into whatever language is appropriate between them and their clients

3 On the other hand materials written in Pidgin would appear to be more acceptable to users, particularly in areas of the country where Pidgin is the normal means of communication, even between English speakers. For use in such areas it might be worthwhile producing a version of the course in which a minimum of instruction in Pidgin was included, but where the main teaching was still expected to be done by an English speaker who had studied the English version. Such a version would be precisely parallel to the English one, but would consist of little more than the same exercises with brief examples. It would be built up with the memo sheets in mind so that the instruction there would be reinforced.

The Workbook was produced just in time for use at the PFA/FTO Workshop in August (for Provincial Financial Advisers and Field Training Officers). It was well received by both groups, including the Leakage Check and the Net Liquid Asset calculations both of which were entirely new to the great majority of the officers present.

After using the new unit on Cheque Accounts it was quickly found to be too confusing, with much turning forwards and backwards to other pages. The work was simplified and the PNG Banking Corporation kindly ran some Bank Statements to our specification on their machine, so that they became more distinctive and recognisable.

At the request of the PFAs an extra sheet was added to the Pricing Unit, listing the current permitted retail markup % on price controlled items. Various officers had had great difficulty in getting access to such a list and in interpreting some parts of it.

The major problem discussed at the Workshop however was that of supplying calculators for resale. Any campaign to get these materials taught to businessmen obviously depended on the provision of calculators but it was not considered generally desirable to let BDOs have supplies in advance of payment. Various means of getting round this problem were devised and the process was encouraged by offering calculators to them at K5.50 each post free for resale at K6.00. The Workbook was sold similarly at 15t per unit post free for resale at 20t. (see Appendix 2, ANR 13).

The Officers were also asked to list the businesses other than trade store keeping for which numeracy teaching would be desirable. Twenty-five such businesses were listed and some attempt was made by the Officers at identifying the mathematics involved in them. No action has since been taken on these however as considerable research would be required in each case and the demand in any one business area would be minute compared with the general need, for example, for keeping a cash book.

The original idea of the Workbook had been that it should be taught either individually on the job or in courses. On the whole the officers felt courses were more popular and less time consuming. On the other hand there is a suspicion that courses are not as cost effective as would appear because they tend to be seen as an end in themselves and as a method of acquiring some sort of Certificate rather than as a way of learning something that will actually be used.

This was underlined by the results of a follow-up of Jonathan Spector's courses in Manus. He had taught a total of 86 students on four courses. Six months later he had an opportunity to tour the island and made an effort to visit as many of the 86 as he could. In a three-week tour he could only find 12: the reasons given for absence from a village when Jonathan arrived to find a client were the usual ones - "in the bush","at the next village", "fishing", and so on.

We shall have cause to refer again later to the practical difficulty of following up a client. (see 3.2.5.4)

Of the 12 Jonathan found only one was still working in a trade store. The other 11 had all started enthusiastically operating the accounting system they had been taught, but had then, for one reason or another, ceased their connection with the tradestore. The cessation did not appear to have been caused by the new knowledge: it seems to be a feature of the area that people come and go in their association with trade stores. It is probable that a proportion of those who originally came were not at the time really working at a store anyway. There was no means of checking. They may well have come just because they liked coming on a course and hoped to have a trade store later.

The main part of Jonathan's course had been concerned with keeping records including a monthly stocktake and daily sales record. But these operations in themselves did not give the owners clear answers to either of their really relevant questions: (a) How much profit have I made? (b) How much have I lost through goods being given away? so perhaps this was a mistake on Jonathan's part.

The use of the calculator as such however was now very much in evidence. Jonathan had himself sold 100 and there were around 400 trade stores on the island. He thought it probable that although many of the stores had had calculators before, a good proportion of them now had calculators that worked, ie with batteries that had not run out; a significant difference. Jonathan's impression was that the calculators sold on his course were now being used for totalling and finding change, and possibly for pricing, but not necessarily by the people to whom they had originally been sold. The one client he did find was using X for pricing, to find out how much he would get for a carton if the units were sold at a particular price

If it is true that familiarity with a calculator is a necessary first stage before using it for pricing and record keeping, then Jonathan's operation could be considered at least an initial success.

A true assessment of the value of the Workbook however must await evidence as to its use in the field. A first questionnaire was issued to all FTOs and PFAs early in 1982 but such enquiries generally result in a very poor response. That was the case when there was an Assitant Secretary at national headquarters responsible for training. In a recent cut-back the whole division of General Business Training (including a staff deployment function) was eliminated so it is likely that requests for information from the centre will carry even less weight in the future. By the end of February about a quarter of the forms had been returned but they were too diverse to show any general pattern in time for inclusion in this thesis. (see Appendix 2, ANR 18 for copy of the questionnaire).

3.2.5 FOLLOW-UP

A certain amount of follow up of training given to village businessmen has however been carried out by the Numeracy Project itself.

3.2.5.1 NIPA

The report on the course at Nipa in the Southern Highlands on 30/31 October 1981 is in Appendix 2 in ANR 3.

The follow-up was carried out by the local BDO who had organised the course. The report on it is in ANR 12.

The Course was for 15 Trade Store Keepers. The materials used were the old Arithmetic for Business units (see 5.7) designed as self-paced material for good English speakers. The exercises were used for class teaching, apart from two older trade store-owners, who did not know their numbers (see 3.2.2 above).

Lunge Rias, District BDO, kindly completed a simple form in April 1981, giving the following information about 12 of the students at the course. (The answers were all "written in" by Lunge; the author did not list any suggestions).

1. Have they still got a calculator that works? Yes - 8, No - 4.
2. What do they use their calculator for? Giving change - 3; cost - 2; pricing - 4; bookkeeping - 5; adding and subtracting only - 2; adding, subtracting and multiplying - 2; checking invoices - 1.
3. Did they learn anything else from the course that they still use?
   Giving change - 12; costing and pricing - 4; checking of invoices - 5; adding and subtracting - 4; memory recall - 1.

4 Do they want more training? Yes - 12.
If so, in what?
Costing and pricing - 8; checking invoices - 3;
percentages - 5; calculator memory - 2;
general use of calculator - 4.

A personal follow-up by the Director has not been possible and there are a number of ambiguities in these responses such as how two of them who have not now got calculators "still use" what they learnt about costing and pricing; but there may be an explanation. The Materials used were highly inappropriate compared with what is now available; the request for further training was unanimous.

3.2.5.2 KUPIANO

The course at Kupiano on 14-27 February 1981 is reported in ANR 8 in Appendix 2.
The follow-up was carried out by the author and his wife personally. The report on it is in ANR 13.

Details of the Course are as follows:

Village	Numbers of students who claimed to have reached the following Education Grades							Sex		Numbers concerned with Trade Stores	TOTAL
	2	3	4	6	8	9	10	M	F		
GAVUONE			1*	6	1	1		7	2	9	9
KELERAKWA					1	1	2	3	1	3	4
WAIORI	1*	2*		1				4		4	4
KUPIANO					1	3		1	3	2	4
WANIGELA		1*		2*				3		3	3
MERANI				1				1		1	1
WAIAVANUA							1		1		1
TOTALS	1	3	1	10	3	5	3	19	7	22	26

*Left after ½ or 1 day

The students details are listed above.

The course consisted of various exercise sheets (ANC Series see 5.10) including totalling and finding change, cross-totalling analysis sheets, measuring with metre rules (it was intended as part of a general adult numeracy campaign experiment so materials were not restricted to those applicable to Trade Store management), multiplying lengths by numbers, checking invoices, totalling notes and coins slips, weighing and selling cocoa/copra, mentally adding single digit numbers and finding change from a kina, pricing goods, proportion for pricing material and PMV charges, use of clock and calendar, miscellaneous questions on × and ÷ and estimating lengths.

We gave them several tests during the course. One was a speed test adding single digit numbers mentally. The results were as follows:

No. wrong, out of 81 questions	0	1	2	3	4	5	
No. of students, out of 19	8	3	5	2	0	1	
Average time taken for these	2m 56s	3m 2s	3m 54s	4m 8s		4m 15s	

A test of their ability to tell the time (in quarters, halves and o'clock) after teaching on the subject, gave the results:

No. wrong, out of 12 questions	0	1	2	3	4	5	6	
No. of students, out of 18	7	5	4	–	–	1	1	

This did not test their ability to say what the time would be in ½, 1 or 2 hours, which they found much more difficult.

Anyone who has attempted to follow-up a research project based on several different villages in Papua New Guinea will appreciate the cost in time, money and frustration in doing so.

To be reasonably sure of meeting one particular person, the researcher would probably have to spend 24 hours in his village and even then there is no guarantee that he will not be away at the time. One cannot normally find out in advance if he is there. Merely to reach any one of three of the villages listed above would require the hire of a boat. Thus the only practical way to follow up a course such as this personally is to put on a second course which may attract as many as possible of the same people and to rely on this and chance meetings to see as many as possible of the original students. Having once achieved one's goal of interviewing the person and tape-recording the result one can still make only a subjective judgement as to the probable truth of what has been claimed. (Further illustration of this problem is given in 3.3.5.4). In the circumstances therefore one feels that a 40% response is quite good. In this case during a subsequent five day visit to Kupiano in August we succeeded in interviewing 6 of the 15 trade storekeepers who had attended the previous course (excluding the 7 who had dropped out after one day). A summary of the skills they appeared to have learnt at the course and now used the calculator for, is given below:

Name.	Calculator now used for
Warikapani	Totalling bills
Gerega	Checking Invoices
Rigolo	Totalling and giving change
Ai Wari	Totalling and giving change, totalling orders, checking invoices, measuring materials
Gideon	Checking invoices, pricing goods, giving change, keeping cash book, teaching others, measuring electric cable
Johnson	Invoice checking, stocktaking, cash book, totalling and giving change, pricing, teaching others

3.2.5.3 LAE

A course for Women and Youth Leaders in Lae, 4-6 February 1981 had attracted 2 male youth leaders and 2 women from the YWCA, all interested in running trade stores, 2 in a centre selling artefacts, 2 wanting to make clothes for sale and only 2 with a more general interest. The full report on it is in Appendix 2, ANR 5. The report on the follow-up is in ANR 12.

One might have thought that follow-up in Lae, the second largest town in the country, in June would be easy. A questionnaire distributed by the Field Training Officer produced two replies from the artefact centre: they claimed to use the calculator for "percentage and memory". On testing them on an invoice however they only used (x) not (M+). They did appear to be using it to total money and find change. Two youth leaders were out of Lae but the typist promised to get them to complete the forms later. One did so, saying he did still use a calculator and was planning to teach others later in the year. Two other students were now on maternity leave. I spent the afternoon seeking them and found that one had used it on her work before going on leave while the other had returned hers to her employer but now wanted one for her father. When in Finschhafen we twice sent our driver to fetch a woman who had come to Lae specially for the course but on one occasion she was in the "garden" and on another she said she was ill. Attempts to find two other ex-students were unsuccessful. The tenth student had only been to Ples Skul (a mission school where the teaching was given in Pidgin or "tok ples": "ples" means village and "tok ples" refers to the local language of that village). We did not find her.

3.2.5.4 MENYAMYA

The course at Menyamya from 2 to 5 June 1981 used the 1st edition of the Business Arithmetic Workbook in Pidgin (see 5.12) and is therefore nearest to a test of the materials which are now available. The students were divided into a fast group taught mainly by me and a slow group taught mainly by my wife. The full report is in Appendix 2, ANR 1 and the follow-up in ANR 17.

The 26 Trade Storekeepers who attended the course had reached the following grades:

5 no school, 2 Grade 2, 2 Grade 3, 1 Grade 4, 11 Grade 6, 1 Grade 7, 2 Grade 8, 1 Grade 9, 1 University dropout.

The Grade reached indicates the number of years they had attended school. There were no businessmen other than these Trade Storekeepers although there were some Government Officers whose numbers are included in the table on 3.5.2.

Only 6 of these 26 trade storekeepers attended the "advanced" course put on in November to try to collect them together for interviewing. One other trade storekeeper was found in the course of a two hour drive to and from Hakwange on an extremely rough road in a Mission vehicle: we did however interview friends of two others who now had their calculators. The other two trade storekeepers who had come from that village could not be found.

The remaining 15 trade storekeepers were even more inaccessable but we did interview 4 government officers and one of their wives who had been on the course. Details of all these interviews are given in Appendix 2, ANR 17.

All interviews were recorded on tapes which are available from the author. Photographs of the 14 interviewees are attached, together with one of the Hakwange road and another of the hill beside it which is believed locally to be the Centre of the Universe. Viewed relatively, why should it not be?

Free translations of the 7 interviews of trade storekeepers referred to above are as follows:

Interview # 1: James Malje, Kwaplalim,
(15 km from Menyamya)

Fast (= Fast Group in June), Gr 4 (= Community School Grade 4 education)

Q (Questionner): You find your calculator all right?
R (Respondent): Yes

Q: How do you use it now?
R: For buying coffee and running a trade store.

Q: How do you use it when buying coffee? Using (x)?
R: Yes.

Q: In a Trade Store?
R: Using (M+).

Q: To check invoices?
R: Using (RCM).

Q: You use it to find change?
R: Yes.

Q: If you sell one thing at K1.25 and another at K6.15 how much is it altogether?
R: (Working on the calculator) K7.40.

Q: Then change from K10.00?
R: (working it correctly) K2.60.

Q: Suppose you have an invoice, can you use the calculator to check it using (M+) and (x)?

(He multiplies the number of cartons by the number of tins instead of the cost of a carton). No. I will teach you this afternoon: you have forgotten.

Interview # 2: Silas Maika, Kwaplalim (15 km) Fast, Gr. 6

Q: You use your calculator in your Trade Store?
R: Yes

Q: To check invoices?
R: Yes.

Q: Will you check this one now?
R: Yes (he makes the same mistake as James did). You have forgotten this.

Q: Suppose you want to total K3.72, K5.85 and K7.43?
(He works it correctly)
R: K17.00.

Q: Change from K20.00?
(He works the sum again)
R: K3.00.

Q: You pressed (M-) instead of (=), but it gave the same result. You use this in your Trade Store? Do you use your calculator for anything else?
R: No.

Q: You use it for totalling and change only?
R: Yes.

Q: I will teach you more this afternoon
You learnt how to use (x)?
R: Yes.

Q: You can use (x) for this one?
(He works correctly 40 (x) 6 (=) (-) 1000 (=))
Q: This gives you change?
R: Yes.

Interview # 4: Kemen Patiea, Panikwa. Slow (slow group in June) no school

Q: Do you use your calculator now?
R: Yes

Q: How do you use it in your trade store?
R: Using (-).

Q: Using (-) for change?
R: Yes

Q: Any other use?
R: No

Q: Can you work this question using ⊖?
(He makes a mistake. Then adds 49t and 24t correctly) Then finds change from K1.00 for 35t. He uses ⓧ instead of ⊖. He tries again. He uses ⓧ again in spite of hints)
Q: You find totals only. Try this one, and write the answer here. (results not recorded).

Interview # 5: Obed Malje, Menyamya. Fast, Gr. 6.

Q: Your calculator still works?
R: Yes.

Q: How do you use it in your Trade Store?
R: I use ⊖ to find change.

Q: Can you do this: K1.25 and K6.15?
R: (He works it out) K7.40

Q: Now find change from K10.00
(He works it with some mistakes, then does it in his head).
Now work this: 68t four times. How much altogether?
R: (He works it using ⓧ : K2.72

Q: Now find change from K5.00
R: (He adds to K2.72 what he thinks is the answer and gets it right at the third attempt).

Q: You work it in your head and check with the calculator?
R: Yes.

Interview # 9: Inok Sakapana, Kokowniye. Slow, Gr. 6.

Q: What do you use your calculator for?
R: Totalling money in a trade store.

Q: Finding change?
R: Yes.

Q: Work this: K2.25 and K1.00 then change for K5.00 (He tries to subtract K1.00 from K2.25) You buy two things: How much altogether? (He gets K3.25) Now change from K5.00 (He does it correctly). Do you use it for anything else?

R: No.

Interview # 10: Alpias Dangi, Menyamya. Fast, Gr. 6.

Q: You use your calculator in your Trade Store?

R: Yes.

Q: What for?

R: To help me to add, to calculate air freight and pricing, but I do the easy ones in my head.

Q: You learned it this time? (He was the only student not interviewed before starting the November course)

R: I learned a little then. I have been looking forward to your coming a second time. Between the courses I used it for adding, finding change, markup, landed cost, adding 10% or 40%-80% on other things. The missionary's wife helps me.

Interview # 15: Abaida Guiyoni: Hakwange (interviewed there). Fast, Gr.8.

Q: What do you use a calculator for?

R: Stocktaking.

Q: How do you do that? (Sr Dockery helped with the questioning)

R: I use ⓧ.

Q: Do you count the numbers of piles on the shelves?

R: Yes.

Q: Do you use the calculator for anything else?

R: No.

Q: How do you find totals like 78t and 39t?
R: I use my head.

Q: And finding change? If a customer buys something for K1.40 and gives you K2.00?
R: 60t.

Q: Do you price your goods in 20t, 30t etc or 24t, 37t etc? (I tried to find out if all his prices were multiples of 10t but failed. I saw later that most, but not all were).
How often do you take stock?
R: Once a week.
(Later, in the store: the first part of the interview was not recorded. He bought coffee and had a scale for weighing it, but he did not use the calculator for working out the price).

Q: What price do you buy the coffee for?
R: 50t for 1 kg.

Q: That is easy. Suppose you put the price up to 55t? Would you use the calculator then?
R: At first I would use the calculator, later I would use my head.

Q: The owner has the stocktake book?
R: Yes

Q: Can you describe how you use the calculator to do the stocktake?
R: I count the tins first then multiply by the price of each. Then I add all the amounts together on the calculator. I do it every Saturday.

Q: What happens when you have worked out the total stock value?
R: I write it in the book for the owner. The owner checks the totals to see if they are making money or not.

Q: You learnt this in the June course?
R: Yes.

Q: Good. I did not believe it was possible.

Two other interviews referred to students who had been at the June course:

Interview # 16: Obed who had been taught by Tom Ikwaiyakuli, Hakwange, Fast. Gr. 7 - who was not available

Q: (The School master helped questioning here). Do you know how to use a calculator?
R: Yes. I use it for stocktaking.

Q: You use it to total money also?
R: Yes.

Q: Did Tom teach you how to use it?
R: Yes.

Q: You use Tom's calculator?
R: Yes.

Interview # 17: Russ, Palalye, he works for Womatoye, Hakwange, Slow, no school - who was not available.

Q: Does Womatoye use his calculator?
R: No.

Q: You do not know how to use it?
R: No. I would like to learn.

Q: I think Womatoye might teach you. Or perhaps Abaidah in Hakwange. You know him?
R: Yes. I have Womatoye's calculator.

The whole operation of re-visiting Menyamya and spending three days there teaching and interviewing had been carried out in response to the very reasonable demand that the research should discover to what extent the local people had benefitted from the work. To be realistic this had to be done in a typically remote area of the country (because most of the country is "remote"). Counting the air fare from Lae, (which I was passing through), my accommodation, a nominal charge for the use of the vehicle and the four days of my time that had to be spent in order to get to, stay at and return from Menyamya, the total cost was K300, (about £210) or K21(£14.50) per interview. If fares from Port Moresby to Lae had been included the total cost would have been K460 (£320) or K33(£23) per interview.

Perhaps this will illustrate the difficulties associated with any attempt to formalise research in a Third World country. The author was fortunate to have received a sufficiently substantial grant from the Government to enable him to carry out some such follow-up. It is unlikely that the government would have been anything like as generous had our application been made a year later. The fund which had provided for us in 1981 suffered a severe cut in its allocation for 1982 and what remained was the object of fierce competion from worthy causes. Such is the effect of falling commodity prices which may marginally reduce the cost of a cup of coffee in the developed world but cause havoc in the economies that are dependent on them.

What evidence then had we gained for our £200 to £300? Little corroboration of claims made by respondents was possible although the details of the interviews do show the attempts of the questionner to discover the truth. It did not help that most interviews had to be conducted in Pidgin which was probably a second or third language for the respondents and a second language for the questionner, who had vastly less linguistic skill than any of those he was interviewing.

There were no convenient sound-insulated booths in which to conduct the interviews. One simply did the best one could wherever one was and if a passing truck did run out of control down a steep hill while one was conducting an interview (as one did) then there just had to be a pause while one ascertained that no one had been killed before one could continue the interview.

In other cases one had to compete with nearby engines running or cassettes playing. The interviewees were after all giving a favour to the researcher by answering his questions. One could not really expect anyone to admit a failure which would lower the respondent's status with the village or in the eyes of the interviewer. Those interviewed always demonstrated the courtesy which one had come to expect in this delightful country, but scientific enquiry does not come naturally to them.

In conclusion then, what can we say? Of the 9 trade storekeepers that we interviewed at first or second hand, seven were still using their calculators three months after the first course. One other had apparently taught someone else and given him his calculator. The ninth had passed on his calculator without passing on the skill to use it.

Of the nine it was fairly clear that most of them cound add money and four pretty certainly used it to find change. Several said they used it for checking invoices, pricing, stocktaking etc and although one would be inclined to doubt these claims the one on whom I did check up (#15) really did appear to carry out a weekly stocktake with it, a remarkable breakthrough.

It was unfortunate that the (expatriate) District Coordinator who had set up the original course had had to be away on this second occasion. His absence made it impossible to find out whether invitations to attend the course had actually been received by the 20 trade storekeepers who did not come to it. It was fairly clear that no one in Hakwange had heard of it so it is likely that the publicity had in fact been poor: it is no use putting up posters or issuing circulars when the people you are trying to inform cannot read. The programme "Tok Save" is designed to overcome this problem by giving out announcements in Pidgin over the radio, but not everyone speaks Pidgin, not everything announced on the radio actually happens as promised (and who would walk 20 miles on the offchance it was actually true?) and in any case it did not seem to be in use in this particular area, probably due to poor reception or relative poverty. (see Appendices to ANR 16 and 18).

If therefore the other 20 trade storekeepers did not hear about the course then one could argue that those who came were a reasonably random sample of the 26 who attended the original course. If they did hear of the new one and deliberately did not come then one would suspect that they were not interested and no longer used their calculators. But even this might be quite untrue. There are any number of reasons why someone who wants to attend a course 10 miles or so away may not do so. While we were there for example there was almost a battle between two villages in the area because of an argument about moving a Health Centre. Such events, or simply a feast or a funeral, would be a substantial deterrent to anyone wishing to attend a course on the calculator especially if they were already using it happily for the particular purpose for which they wanted it.

Regrettably therefore, one must admit that the evidence from the follow-up, obtained at such cost, is hardly significant. This however does happen even in well organised research in the western world. Judgements in the end have to be made on fairly slender evidence, particularly in the Third World. Time, with a bit of luck, may tell. What is certain in this particular case is that those who did come to the second course responded extremely well to it and were far easier to teach than they had been on the first occasion.

3.2.5.5 BEREINA

The original intention of the Business Arithmetic Workbook (5.12) was that it should be used by BDOs with clients either individually or in groups. It is too soon to provide any record of follow-up of such training but the report of one Field Training Officer who conducted such a course in Bereina is available. [148]

6 Businessmen were taught with education ranging from Grade 4 to Technical College and National High School. The course conductor reported that the course had proved to be a success because:

" 1 The participants were in high need of such a course
2 Most of the participants have some idea of numbers and signs

3 The language used is simple and the course conducted at the pace of the participants understanding

4 Most of the participants are Trade Store owners. "

At first there had been some difficulty because of "signs and memory" but by the end everybody knew the basic ideas of the calculator and the use of it, especially for "working out prices and use of memory in dealing with customers". The participants were enthusiastic to apply what they had learnt in their trade stores.

3.2.6 NEEDS OF BUSINESSMEN FOR MORE NUMBER SKILLS

These needs, on which the whole project was based, were often illustrated on our tours. Some samples follow:

A trade store manager in Mendi was selling cheesepops at a loss while rice, for which the price was controlled, was substantially overpriced (Appendix 2, ANR 3)

Due to the high cost of freight in the Southern Highlands and their failure to take it into account when pricing, a trader in Karil was selling blankets at K4.40 when they had really cost him K7.22 (ANR 3).

A storekeeper in Lae helped by the BDO kept a cash book with analysis columns. When I was explaining how to cross check the totals and balance I uncovered an error of K100 (ANR 5).

When checking invoices at a Haus Kai in Goroka I found the total on one was K361 when it should have been K180.50. The error had not been noticed (ANR 9)

The ablest of a group of businessmen attending a course at Kiunga assured me twice that K284.15 was more than K380.29 (ANR 15).

3.2.7 CONCLUSIONS CONCERNING BUSINESSMEN

Note: these and other such conclusions are based on experience gained through the Numeracy Project. As has been explained, formal validation of such conclusions would be expensive to obtain and the cost of doing so would not be justified unless serious doubts were expressed about the truth of the assertions:

1 The vast majority of businessmen in PNG need more arithmetical skills

2 The provision of long-life battery calculators and appropriate training can meet this need

3 The Business Arithmetic Workbook (the 1981 edition in English, see 5.12) provides appropriate teaching material

4 It needs to be supplemented with "memo sheets" and probably a Pidgin version

5 All Field Training Officers have been shown how to use this material and have been urged to pass on this knowledge to all their Business Development Officers for teaching clients individually or in groups

6 Ways are being found of meeting the need to supply calculators at minimal cost to clients

7 This training of clients and provision of calculators needs to be monitored for some time to come. In the absence of a General Business Training division in the Department of Commerce responsibility for this monitoring will presumably rest with Laloki College and the Numeracy Project.

3.3 VILLAGERS WHO KNOW THEIR NUMBERS

3.3.1 REACHING THE CLIENTS

The main problem with villagers who were not trade storekeepers (and we met few other "businessmen" in the villages) was that they lacked the motivation to come into a town for a course.

Our first attempt to overcome this was in the East Sepik in November-December 1980 when with the help of a senior Business Development Officer we persuaded "big men" in six villages to send "representatives" to a four day course in Wewak. Those who came were mainly young people without standing in the village. We taught them deliberately how to pass on the skills we were teaching them and hoped that the influence of the "big men" would ensure that they did in fact teach the other adults in their villages. (ANR 4)

The more we learnt about village life however, the less confidence we had in this idea. When we did eventually visit Wewak again and interview six of those we had taught, we were not surprised to find that only one of them claimed to have taught any other person. The one who had, had taught one school-girl. (ANR 16)

We attempted to gather a similar group of representatives for a similar course at Popondetta in May 1981, but the gathering had been at second hand and no one in this category turned up (Appendix 2, ANR 11). So on our next tour in Morobe (ANR 12) in June we decided we must take the initiative ourselves. We hired a Land Cruiser and set out with a business development officer to visit the villages on the road running southeast from Wau. It happened to be the Queen's birthday (their Queen as well as ours) so school children were at home and at our first stop we taught four men and four boys. At the next village we taught six men, three girls and a boy. Two days later, after a trade storekeepers' course in Wau, we set out again at 3.20 pm and reached a village at 3.45 pm but were told that most of the people were still out at their coffee plantations. The same thing happened at the next village although we did there teach two men who were most keen that we should come back, preferably on a Sunday and teach the many Grade 6, 7, 8 people they had in the Village. Alternatively, I suggested we might warn them in advance by Tok Save when we were coming: they agreed that this might work but added that we should mention them by name in the message. On our way back to Wau we revisited the village we had reached at 3.45 pm but even then at 5 pm no one had returned and we were assured that when they did they would want food and a wash before learning. Village habits would depend on the situation of their gardens and the work they had to do in them. Night falls soon after 6 pm.

On our next tour based on Kupiano (ANR 13) we tried to extend this approach. The idea was to tell the people we were coming and hope they would remain there to meet us instead of going to work. It had mixed success, depending mainly on the enthusiasm with which the message was delivered to the village. Sometimes the message had not got through at all, when the only people we could find might be the old non-schooled people who generally did not know their numbers and were almost impossible to teach in a couple of hours, or the young "Grade 6" dropouts who appreciated our visits but had no standing in the village, nor money to buy a calculator.

The main publicity was by Tok Save (over the radio), when the Business Development Officer would give details of our arrival. This sometimes resulted in a group of trade storekeepers appearing, but we found there was a good deal of cynicism over Tok Save messages. We had more sympathy with this attitude after we had ourselves had to break a promise to turn up at a particular village on a particular day.

Villagers were not surprisingly hesitant to abandon their normal work-habits for the sake of a new and untried experience which must have seemed pretty pointless to many unless they already had business interests.

Originally we had thought of making more than one visit to a village but we decided that this would be unproductive because the only material with universal relevance was in totalling and finding change, and this they either could or could not do at the end of the first visit.

3.3.2 WOMEN's WORK

In Goroka, Madang and New Ireland we arranged our visits through the UNDP/ILO Women's Project. This generally ensured a good basis for our visit, except when their organisation broke down. On the other hand a larger proportion of the women were unschooled and did not know their numbers, which made teaching on a brief visit with a calculator very difficult.

This however raised in starker form the basic question of the purpose of our work.[†] Were we just there to provide a useful skill? If so these visits were wasted because few women had any expectation of using such skills: one of the most competant women we met (Iruk Malai in Mawan, Madang Province, ANR 17), assured us that although her brother ran a trade store he would never allow her to help with the money side of it. Out of the 142 women we met connected with the ILO Project in Madang only one (apart from the ILO associate) was managing a business and she had to hand over all her takings to her husband who then failed to use them to pay the rent on their premises. In New Ireland, similarly (ANR 18) apart from the Kai Bus (mobile canteen) operated by the project itself, we only met one business woman.

Our experience in Goroka (ANR7, 9) was particularly interesting. The Womens' Project there is responsible for quite a high-powered food business operation and I was able to meet their general manager, their Haus Kai (cafe) manager, their accountant, a woman's representative in the Provincial Government and the woman BDO (all "national" women), along with the expatriate Project Manager, a Research Officer and a volunteer teacher of informal womens' groups named Monika Schmidt.

They were none of them very sure that numeracy teaching would be seen as relevant by village women, or indeed by any women other than those actually engaged in the Project business. I persuaded them however that they were the only people who could pass on this sort of education to women in the villages and on this basis they agreed to attend a 3 day course in March.

My wife who assisted in this teaching was convinced at the time that nothing would come of the attempt, and the follow-up enquiry justified her doubts, (ANR 12). Monika reported that none of the women appeared to have any intention of passing on the skills to others. To check this I sent questionnaires with reply-paid envelopes to the 10 women who had attended the course. Five responded. One had taught her children and two young girls, another had taught her father and some young girls from her village, the BDO had taught three friends, another reported simply that the village women had neither time nor interest.

[†] see 3.3.5 for an attempted answer to this question.

Monika Schmidt's response was illuminating and was the subject of a further report in November (ANR 17). She had taught various groups of women.

One group consisted of 12 village women for six months: from not being able to write numbers they had learnt in 8 lessons how to add and subtract on the calculator. Learning the numbers was most useful but anything more turned out to be impractical. Coffee was sold to the buyer offering the highest price for the package so the price per kg was irrelevant to them. When it came to calculating change they either shopped in big stores where this was worked out for them on a sophisticated till, or they went to a local store run by a male wontok (person speaking the same language, ie a friend) whom they would not dream of offending by actually checking the accuracy of his calculation. Their only'business' was selling vegetables and the price was determined by supply and demand: if they had to travel to Lae to sell them the cost of the fare would be written off as part of their fun in visiting relatives.

On the other hand Monika had also taught small groups of women who were planning to take over businesses next year and for them everything was worthwhile: cash book, invoice checking, pricing goods and even proportion to find the charge for 2 days baby sitting given the price for 5 days.

A youth group however, who were involved in a baking business had found ways to simplify their calculations so that they did not need a calculator: they had learnt how to divide a sum of money by 10 so could find the price of 1 kg of flour in a 10 kg bag. They found the price of 3 kg by repeated addition and could divide by 2 to find the cost of half a packet of sugar. They also knew that they should sell for double their cost so they (probably) rounded to a kina and could then tell how many 10t cakes they must make out of their dough. One would not expect to find such a sophisticated group of youngsters anywhere except in a big town like Goroka.

3.3.3. NEEDS

The needs of villagers for further number skills were illustrated by the following incidents:

A girl serving in a store in Kupiano said that the old people who had learned pounds and shillings painfully had now given up and asked for help with money in the store. (Appendix 2, ANR 1).

A group of women in Gavuone knew they were often cheated when buying and selling (ANR 1)

Some women in Wanigela made skirts but not dresses because they could not measure (ANR 1)

The Manager of a Village Development Centre at Popondetta said that his staff had visited each of 12 villages weekly for 3 years to encourage village industries but the whole programme needed revising in the light of the villagers' failure to understand numbers (ANR 2)

A group of responsible Mothers Union Officers meeting in Popondetta had no idea how to work out the price to charge for their macrame work. A ball of string cost K1.95 and made 2 pot holders but they could not see that this meant the cost was about K1 each (ANR 2)

A family in Kanipe village needed to know how to price their scones. They also needed a watch and to know how to use it so that the bread they cooked in their drum oven would not burn (ANR 2).

Women in Embi village were sure that K1.10 of sugar, 65t worth of fish and 60t of rice came to K2.60 "because it always did" (ANR 2).

In parts of the Southern Highlands they still counted money in pounds and shillings; they knew 60t as 6 shillings but had no idea about 23 toea (ANR 3).

They also thought the coffee buyers cheated them but few could argue the matter (ANR 3).

A Community School headmaster wanted to get his School Office roofed with iron instead of bush materials but could not work out how many sheets he would need (ANR 3).

Only one out of a group of 10 women and youth leaders on a course in Lae knew how many toea there were in a kina. One guessed 25 then 50 before suggesting 100 (ANR 5). We received similar responses on other occasions.

The mother of a course member had just made and sold tapioc parcels in the market at an overall loss of 30t, although this did not take account of the fact that she had most of a packet of salt left over and that she had eaten two of the parcels (ANR 9, section 7).

In a "fast" group consisting of the brighter students on a course, I had much difficulty in explaining the concept of "how much longer". When asked this about two pieces of material the first student did put them side by side but he proceeded to measure the wrong length and was surprised not to get the answer he had obtained by subtraction (ANR 11:7).

On a Palm Oil plantation boss-boys were in charge of ten to fifteen labourers but they were not always able to count their men correctly (ANR 11:11).

Students on courses frequently had difficulty in determining which was the larger of two numbers. One was quoted by an outside observer as having "acute difficulty in deciding whether 77 was greater or less than 74" (ANR 11: Appendix)

When a client had paid part of a bill the brightest of my students in one course wanted to add the part to the whole to determine how much more was to be paid (ANR 15:6)

3.3.4 MATERIALS

The previous section illustrates the variety of needs that may be met with in village work. From October 1980 to July 1981 we produced at least 56 different exercises (the ANC series, see 5.10) including: totalling and finding change with and without the calculator, cross totalling, checking invoices, notes and coins slips, number game using the constant function, adding, subtracting, multiplying, dividing, estimating and comparing lengths, weighing and selling coffee, listing and pricing timber requirements, the clock, the calendar, profit, stocktaking, leakage, pricing food, pricing sewing, PMV charges, comparing prices in a supermarket, stock control, wages, Church health service forms, pricing artefacts and services, costs of eggs, printing, second hand clothing, travel, lumber, air freight, rice by the cupful, cardamom projects, cattle projects, plantation areas, numbers of truck loads needed, finding page and hymn numbers.

In June we prepared materials specifically for use in village visits lasting an hour or two. These consisted of AND 1,2,3, (see 5.11) a set of three A4 sheets each ruled into three sections so that they could be folded with one section only showing, the rest being folded underneath to give a thickness which facilitated writing on it on the knee, the nearest bit of wood or on the ground. The series was in Pidgin, very crowded on the paper and printed in haste from a hand-written copy.

AND 1 included totalling, finding change and cash book. In the latter the balance was to be found on each line and then checked at the end by totalling the IN and OUT columns. Additional practice was given on the back of the sheet. AND 1 was subsequently rewritten in English with answers to all the questions on the back, typed and renamed FCC 1: our First Calculator Course. This sheet became the basic introductory material used thereafter on every occasion except when the first unit of the workbook was appropriate. AND 2, and subsequently FCC2, introduced the memory first as a means of overcoming the problem of totalling the cost of purchases when ⊕ has been used before ⊗†. I was never quite clear how desirable this was although I included it in the Workbook also because it did seem to me to illustrate a basic reason for using the memory. It also encouraged them to use (x) and (+) or (-) in the same calculation while warning them of the dangers of doing so. This was hardly "village" level teaching but for the brighter Grade 6 and 7 levels or above it seemed to me to represent a piece of worthwhile concept development. I often omitted this part when using the sheet in the villages and went straight on to the more obvious uses of the memory for invoice checking and Notes and Coins slips where the numbers of notes and coins of different denominations had been recorded and the object was to find their total value. This is the sort of slip that is used in some large stores: it seemed to meet a need in womens clubs for example where I was told they sometimes had to get a man in to count the money for them.

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† Some calculators are designed to do the multiplying before the addition, but that is not the case with most "basic" ones.

AND 3 (and FCC 3) was an attempt to produce concept development in the meaning of (x) and (÷) and in length. It also gave a few examples of pricing. The backs of the sheets provided cumulative revision work.

Test sheets were also prepared in association with each of AND 1,2,3, each in several versions of similar difficulty to defeat inveterate cheats, but these were rarely used.

3.3.5 FOLLOW-UP

3.35.1 WOMENS WORK

We were not able to follow up any of the brief village visits which marked the later tours but one would not expect a high level of response from a 1 to 2 hour course. This particularly applied to the women many of whom had had no schooling and hardly any of whom had any business expectations. On the other hand it could be very significant for a woman to have acquired, for however short a time, an academic skill which her husband might well have envied. The "conscientisation" process by which women in a country like this will gradually become aware of their own potential for working in "men's" fields, is bound to be a long-term and expensive task from which specific results will only occasionally emerge.

Perhaps some attitudinal test could be applied but there cannot be much local experience to work on in this field. Rose Kovero, ILO Associate in Madang and Iruk Malai, one of their directors, both assured us that the operation was worthwhile. (Appendix 2, ANR 17).

The women themselves demonstrated their belief that it was important, even when they must have known that they might never be allowed to run a business. The group of women who walked 24 km one tropical day to attend a course must have had some belief in the value of what they were doing. We also noted that when we ran a course at Madang for those who had attended village courses in the area, 5 men and 9 women travelled an *average* of 41 km each to attend it. The similar course in Kavieng (ANR 18) was attended by women and men who travelled similar distances.

.3.5.2 KOROBA

Perhaps the most significant follow-up for non-business people however was for the course at the Guala Christian Centre at Koroba in connection with the Literacy Programme in the Southern Highlands. Here we put on a revision/advanced course and the Mission urged all who had attended the 4 day course there in April (ANR 10) to return for a weekend in September (ANR 14).

Jenny Fountain from the Mission had already interviewed 21 of the 34 original students (6 of the other 13 students lived more than 40 km away) and completed a questionnaire for them, providing the following replies:

Do they use a calculator now?
Yes, 20, No 1.

Do they now use the metre ruler they purchased for measuring?
Yes 6 No (or did not buy one) 15

Do they now use any of the games they learnt at the course (Snap, Sum-ten, Car Race game or Calculator number game)?
Yes 13, No 8.

What did they learn on the course and now use?
Positive response 20, Negative 1.

Have they taught anyone else anything they learnt on the course?
Positive 13, Negative 8.

Do they want to learn any other number skills, if so what?
Positive 17, Negative 4.

The "skills learnt on the course and now used" included adding money for church, Bible school, trade store, womens fellowship, bookshop, medical accounts, wages, etc, playing games with a friend and for own amusement, and pricing in a trade store.

Those they have taught include literacy teachers and classes, their own children, trade store boys, a class of 10 villagers learning number skills and nurses needing to calculate mileage and other statistics. One said he wanted to teach the use of the clock.

"Other number skills they want to learn" were in fact mainly revision of those already taught to them, as one would expect. Some just said "More practice", others mentioned specific items such as the memory, %, cheque accounts and the square root.

My wife or I also interviewed 13 of these 21 and recorded them on tape (available from the author). Some of these interviews were in English and others in Pidgin. They generally expressed the enthusiasm of the students. One particularly recalled learning to count up to 19 and down to 1 again. He had found learning to add and subtract hard but easy with the calculator. He did not lend it to his literacy students but used it himself when teaching them. He wanted certificates to be given to those who learnt how to use the calculator. He wanted to know about the square root key which he described as "T".

One young Grade 8 leaver described teaching the calculator to 7 people in his village. He remembered about the ruler without being asked: he used his calculator to help two old village trade storekeepers to count their money, now he would be able to help them keep cash books.

One had been teaching his literacy students how to add and subtract. He had forgotten a lot of the things he had learnt at Easter but now he remembered them again. Another had forgotten everything about the calculator, which was why he had returned, but he had been using the ruler to measure. A nurse had been using the calculator a lot in her job. A woman literacy teacher had been teaching women and children to use the calculator. A pastor had been teaching numbers to 10 village people and also the calculator to a trade storekeeper. He had now learnt to keep a cash book.

The Church Secretary had learnt many interesting things including looking after money and "checking up on things" with the calculator. He had taught his children to measure with the ruler and to use the calculator. He knew he must practise if he was to retain his skills. A trade storekeeper took his calculator with him to check the invoice before he left the bulk store, and used it to price his goods afterwards. He used the ruler to measure material for sale. He had taught his work boys as well. He thought he might be able to remember how to keep a cheque account but would really like another lesson first.

Our own experience of teaching these "returned" students was most memorable. Previously they had struggled and frequently pressed the wrong keys. Now they were confident and tolerably accurate. In 2½ hours I was able to teach the whole of AND 1 and AND 2, including the new work with the memory and the Cash Book. This was comparable with Groups of Government Officers I had taught and it was obvious that even if they had forgotten the more complicated processes they must have spent a lot of time on the calculator with the simpler ones. They were now in some sense at least, numerate.

3.3.6 CONCLUSIONS CONCERNING VILLAGERS who have no businesses at present, but do know their numbers.

1 Most villages include some men and women with enough schooling to "know their numbers" ie: to be able to count objects and relate their counting to the Western system of numbering

2 Few village men or women (unless they are engaged in business) can do more than add simple numbers together. Subtraction, multiplication and division have generally been forgotten if they were ever known

3 Given careful planning and publicity and the support of local organisations and appropriate teachers it should be possible to provide village based courses that would give the average schooled villager the ability to carry out simple numerical exercises such as totalling money, finding change and keeping a cash book

4 The First Calculator Course Unit 1 (see 5.11) provides appropriate material for such a course

5 The long-term response to such a course will depend on the motivation of the villagers and their ability to obtain calculators

6 In some cases, particularly with women, the provision of such courses, may be justified on the grounds that they raise the recipients level of consciousness of number even if they do not actually ever use the skills taught on the course.

3.4 VILLAGERS WHO DO NOT KNOW THEIR NUMBERS

We have referred above in 3.2.2 to two trade store owners who did not "know their numbers" ie: could not count objects and relate the result to the Western system of numbering. We have also referred to the high proportion of women in this category. During our village visits if such people were given a calculator someone else nearby, perhaps a child, would help them and on the whole they did not lose face although obviously they could not learn much in an hour or two. Some better system must be provided if they are to acquire the basic knowledge.

3.4.1 TEACHING THOSE WHO DO NOT KNOW THEIR NUMBERS

There are some 250 different sorts of traditional number systems in the country, but these are generally little more than methods of counting by associating numbers with parts of the body. They do not help, directly at any rate, with such tasks as adding two single digit numbers together or finding the change from a kina. Neither do they help with pressing the correct keys on a calculator.

To teach a person their numbers (Western style) is a long job, comparable with teaching literacy but a good deal easier. There is only one large scale literacy project in the country and that is in the Southern Highlands which was fortunately one of the Provinces where the Project worked during 1981.

Our first visit there was 29 October to 8 November 1980, (Appendix 2, ANR 3) when we met the Adult Education Officer, Joseph Ogaie and John Crofts who together were responsible for supporting a Literacy Programme that was largely operated by the Churches through 400-500 teachers and 50 supervisors. The latter were meeting while we were in Mendi and we were able to talk to 14 of them in an informal group. They were unanimously keen to include numeracy along with their literacy teaching.

Our second visit (ANR 10) therefore was timed to coincide with a meeting of the Provincial Literacy committee at which we offered to prepare a programme for incorporation into their scheme. This they welcomed.

In preparing it I studied courses produced by Jenny Fountain of the Christian Brethren Church, another course prepared by a colleague of hers and one by Sr. Kristen Whitehouse of the Erave Catechist Training Centre.

I was impressed by the enormous range of material included in these courses and the fortitude which any villager and his teacher must have possessed in order to complete them. One of these courses included 40 assignments covering numbers up to 1000, adding money, multiplying by 2 and 5 and working out invoices using these two multiplication tables only. Another course of 30 lessons extended addition and subtraction in column to numbers up to 1000 including ten lessons on addition and subtraction of dollars and cents. The third course was a 2-book affair including all multiplication tables, measuring, halves, quarters, tenths, decimals, rectangles, litres, kilograms and grams, telling the time and the number of days in months and years.

Knowing the difficulties found in some of these topics by students with 10 years of formal education and knowing also that a very large proportion of the work could be done directly with a calculator anyway, I had no intention of including even a fraction of this material in the course I was preparing for the Literacy Programme. But even so I was not prepared for the shock we experienced when on our third visit in Septmber 1981 (ANR 14) we actually taught 25 Huli teachers and supervisors and 11 others at the Asian Christian Pacific Mission at Tari.

In the first place we were a little taken aback to find 16 of the teachers had had no formal schooling themselves and about half of them had to be taught in the Huli language. There was no reason why this should not be so since the Programme was concerned with literacy in Huli, but we had not met so many un-schooled educators before who could not even speak Pidgin.

Fortunately, we had one of the national experts on Huli with whom to work and he was as concerned as we were to devise an appropriate numeracy course so translation was no problem though feed-back was difficult.

They were in fact generally able to count up to 100 and knew their numbers already so this part of our course was a case of teaching techniques for teaching. When it came to teaching number bonds for sums of single digits however we felt we were wasting our time with the non-schooled teachers and supervisors.

How often, we wondered, would they really need to know that 5 + 6 = 11? They could work it out on their fingers or find it out on the calculator if they did want to know and really there seemed no justification for the sweat needed to memorise these results which would almost certainly be forgotten soon afterwards through disuse. We concluded therefore that the only number bonds we should expect everyone to learn in our revised course would be those involving +1 and -1, ie. being able to count forwards or backwards from any number. This would enable them to work out sums and differences with objects or on their fingers if need be. Number bonds for 10 also seemed worthwhile because of "change for a kina".

We had thought the calculator could be used with the constant function as an aid to learning these results but the frequency with which most of them pressed the wrong key and had to re-set their machines made us doubt if it was worthwhile. This however was only the first day they ever handled a calculator. It would have been better to start with a "straight" use of it.

When it came to using the calculator to total or multiply money and find change we did better although even here the non-school group made heavy weather of it. We gave them a test consisting of 12 such questions and the 26 teachers and supervisors scored as follows:

Score out of 12:	12	11	10	9	8	7	6	5	4	3	2	1	0
No. of students:	2	2	3	2	1	4	-	2	2	-	2	3	3

Considering that this was only their second day with calculators and that 16 of them had never been to school, we felt this was reasonably good: many mistakes had been only due to confusing 5 and 6 or making whole kina entries.

Those who scored less than half-marks on this test continued revising the same work while the rest tackled the Cash Book, finding the balance for each entry and checking the final balance by totalling. Tests for these 11 involving cash book, notes and coins slips and totalling with mixtures of x and ÷ gave the following results:

Score out of 39:	39	37	35	34	30	29
Number of students:	1	2	1	2	4	1

This was a tolerably good result. As we have mentioned earlier, a similar group in Koroba made enormous strides once they had had plenty of basic practice with the machine, so we reckoned a little re-training later on would make them well able to teach these skills.

We were particularly anxious to include the Cash Book in our revised draft because of the frequency with which we heard that club and church treasurers, secretaries, etc, either lost money, stole it, or nearly as bad, were thought to have done these things. The Cash Book is the one essential if money is to be looked after properly. It only involves adding and subtracting but it can also help to teach what these processes mean, for it was by no means obvious to those we were teaching that they must use "plus" for IN and "minus" for OUT. The Cash Book also offers training in checking and correcting mistakes.

A second draft of the Basic Numeracy Course for the Southern Highlands Literacy Programme (see 5.13) was sent to the Committee in December 1981 for consideration. It includes a Teachers Book with 26 lessons very precisely set out in English (which will need to be translated) and details of exercise booklets, test booklets, number cards and "snap" cards which will be needed.

The first 17 lessons include counting up to 30 objects, games to teach "one more" and "one less", using the fingers to add numbers up to 10 on to numbers up to 20 and telling stories to illustrate addition and subtraction.

The remaining 9 units cover totalling money (+ or x but not both), finding change on the calculator and keeping a cash book.

Number bonds for 10 and change for a Kina have been omitted from this draft but should probably be inserted and practised using the constant function on the calculator (pressing 10 ⊖ ⊜ followed by numbers and ⊜) and the sum-ten game.

3.4.2 CONCLUSIONS CONCERNING VILLAGERS who do not know their numbers

1 Teaching adults their numbers is a lengthy process which is best done in association with some other long term educational operation such as a literacy campaign or prolonged contact with a Vocational Centre, Community Centre or the like

2 A possible basis for such a course has been prepared for the Southern Highlands Literacy Programme but much trialling translating and amending of the course will no doubt be necessary before it can be used effectively

3 Any other literacy programmes to be set up in the future should, if at all possible, include an appropriate numeracy section

3.5 GOVERNMENT OFFICERS AND OTHERS who have already used a calculator but lack the skill to use it effectively or the confidence to teach others to use it

3.5.1 INITIAL BROADENING OF EXPERIENCE

It has always been part of the work of the Numeracy Project to help train Business Development Officers. What was not so obvious, and what might never have happened had it not been for the good will of the Department of Commerce is that the Project has also from the beginning been allowed to help other agencies meeting similar problems. Initially this was of great benefit to the Director who had had no previous experience in Commerce and needed the experience he could gain from related areas.

Between March and October 1980 the Project was involved in the following:

Laloki College (Basic skills and Commercial Mathematics course for Salesmen, see 5.1, 5.2. Also selection test).

Hanuatek (the keeping of simple cash accounts).

W R Carpenters (calculator course for salesmen, see 5.4).

Steamships (course for drivers giving credit for returned empties, their selection exam and advice on new counter calculators, see 5.5).

Plantation Management Training Programme (course, see 5.8).

Small Industries Research and Development (accounts for potters).

Port Moresby School of Nursing (calculator solution to some standard problems).

Air Niugini (calculator course for domestic air freight clerks, see 5.6).

National Capital District Business Development (some regular clients).

Department of Commerce Women's Work (questionnaire).

Bankers College (advice on their course).

Melanesian Council of Churches (accounts).

3.5.2 CONSULTATION AND TRAINING

In October 1980 when the grant was received to investigate the possibility of an Adult Numeracy Campaign, I began to consult other departments particularly those with extension officers. This very often led to a request to conduct courses on the use of the calculator for such officers.

The following table indicates the number of officers consulted and the number of officers trained in each Division in each Province between March 1980 and December 1981.

NUMBER OF GOVERNMENT AND CHURCH/MISSION OFFICERS A) CONSULTED & B) TRAINED BY THE NUMERACY PROJECT MARCH 1980 - DECEMBER 1981

	The five "experimental" provinces										Other Provinces visited													
Province	Central		East Sepik		Morobe		Oro		S'thern H'lands		E'tern H'lands		Madang		W'tern		N Solomons		New I'land		NCD Nat HQ		TOTALS	
ANR References	1 6 8 13		4 16		5 11 12 17		2 11		3 10 14		7 9 17		17		15		18		18		1 4 9 10 11 14 17 +			
Number of Govt Officers	Consulted	Trained	Consulted	Trained	Consulted	Trained	Consulted	Trained	Consulted	Trained	Consulted	Trained	Consulted	Trained	Consulted	Trained	Consulted	Trained	Consulted	Trained	Consulted	Trained	Consulted	Trained
Commerce	5	2	11	3	5	10	2	9	4	-	4	1	1	-	1	-	5	-	4	-	21	1	63	26
Community & Family Services	1	2	1	3	2	-	2	-	2	-	-	1	1	2	-	-	-	-	-	-	4	-	13	18
Non-Formal Educ	1	-	2	2	4	1	2	5	6	4	-	-	-	-	1	2	-	-	-	-	-	-	21	24
Health	2	4	-	-	6	11	-	-	4	26	-	-	-	-	-	-	-	-	-	-	-	-	12	41
Primary Industry	-	6	5	7	8	10	-	-	-	9	-	-	-	-	1	-	-	-	1	-	2	-	17	32
Provincial Admin	1	2	3	1	5	6	1	-	5	12	-	-	-	1	-	-	-	-	-	-	1	-	16	22
Business Management	1	4	-	-	3	8	-	-	1	4	-	-	-	-	-	-	-	-	-	-	-	-	5	16
Miscellaneous	-	-	1	-	4	1	-	-	-	5	-	-	-	9	1	-	-	-	-	-	14	12	20	27
Total Govt Officers excluding Formal Educ	11	20	23	16	37	47	7	14	22	70	4	2	2	12	4	2	5	-	5	-	47	13	167	196
Formal Education	-	1	2	-	4	2	-	-	5	23	4	-	-	-	1	6	-	-	-	-	8	409	24	441
Church/Mission	2	-	2	-	3	-	3	7	8	80	2	1	-	-	4	14	-	-	-	-	-	-	24	102

NOTES ON THE ABOVE TABLE

1 The first five Provinces listed were those with which the Project was particularly concerned, the others were visited for specific purposes

2 "Miscellaneous" included the following:

Village Development
Works & Supply
Post & Telegraphs
Public Solicitor
Other Education
Physchological Services
Price Control
Development Bank
National Planning Office

3 An officer being "Consulted" here means that not more than 3 of them were consulted at a time. Consultations of larger groups are listed below:
these numbers are not included in the table above.

Larger Consultations involving the Numeracy Project June 1980-December 1981

1 Six meetings of the Post Secondary Mathematics Group, Port Moresby, including one demonstration lesson [40]

2 A meeting of about 12 Mothers Union Officers in Popondetta (Appendix 2, ANR 2)

3 Five Rural Development Officers at Mendi (ANR 3)

4 Workshop on Role of Women Instructors in Vocational Centres, Mendi (ANR 3)

5 A group of 14 Literacy Programme Supervisors and Coordinators in Mendi (ANR 3)

6 Two meetings with District Officers in Lae (ANR 5)

7 The Annual General Meeting of the Melanesian Council of Churches, Goroka (ANR 7)

8 The Provincial Literacy Committee for the Southern Highlands, Mendi (ANR 10)

9 Mathematics Education Conference, Lae (ANR 11)

10 Primary Mathematics Conference (See 2.3.2)

11 Inservice for Staff at Maprik High School (ANR 16)

12 The Numeracy Project Steering Group, Port Moresby, (see 3.5.6)

Also the following in which both consultation and training took place

13 Laloki College Staff meetings and Diploma courses

14 Workshop for FTO/PFA Laloki (see 3.2.4)

15 Two Regional Conferences for Managers of Vocational Centres (ANR 16 & 17)

16 The 4th National Workshop for Mathematics Groups, Goroka (ANR 17)

Given the limitations of communications and time,(particularly as most of these meetings took place during 1981) one could certainly claim that the Project has done its best to consult with others.

Its contribution to training Government Officers has also been substantial considering that this was an'extra' which had not been anticipated. It is hoped that this will prove to have been a good investment: it could indeed prove to be the key to success in so far as the future of adult numeracy in PNG may well turn out to be almost entirely dependent on the goodwill and enthusiasm of such Government officers.

.5.3 NEEDS OF GOVERNMENT OFFICERS

The needs of Government Officers for training were frequently exemplified.

5 out of a group of 25 Aid Post Orderlies were un-schooled and not able to write amounts correctly in kina and toea. When the

group as a whole was asked which month was 2 months after February, both March and May were suggested before April. The date one year after 6 February 1981 also produced alternatives, the most favoured being January 1982 (ANR 10:4).

Group of 12 District Officers (probably all Grade 10) followed the procedure for calculating the number of litres per hour required for a village water supply. It came to 1150 and the stream was flowing at 4500 litres per hour: the majority of them however then assured me that this was not enough. Subsequently they were equally unable to determine whether a supply of 1150 litres per hour was sufficient if 700 litres per hour was needed. (ANR 14: 13). The ability to compare numbers is very weak even in Grade 10 graduates: 27% out of 2243 tested in post secondary institutions in 1978 had been unable to identify the biggest number out of 365,192 and 69. [32]

A DPI Officer brought me a sample of a Development Bank Application form to illustrate the work they had to do for Rubber Block holders. A number of corrections had already been made to the completed form but there still remained three errors: multiplying 350 by 11t, finding the cost of 350 m of wire at 90t for 30 m and 15% of K400.29 (ANR 15:2).

3.5.4 CONSULTATIONS

Consultations were generally most supportive to the work once it was made clear that the batteries in the calculators would not run out. But the main purpose behind this work with Government Departments lay in the realisation that their extension Officers provided the most potent force of adult educators in the country. It was therefore of great importance to identify the skills which they might be willing to teach to their clients. In the same way that the Project had been born out of a recognition that Business Development Officers were doing many things for their clients which the clients might do for themselves, given sufficient numeracy skills, so it was reasonable to suppose that other extension officers were also carrying out calculations for clients that the clients could be taught to do for themselves. Self-sufficiency of the individual, as of the state is one of the primary aims of Government in Papua New Guinea.

Many consultations were therefore directed to this end and exercises were produced illustrating ways in which clients could be taught to make relevant calculations for themselves.

3.5.5 RELEVANT EXERCISES

Such exercises included the following: (from the ANC Series 5.10)

3.3 Weighing coffee/cocoa and finding the total price for selling it.

3.4 Timber Requirements: listing the numbers of pieces of each size.

5.2 Pricing cooked food.

5.3 Pricing sewing.

5.12 Pricing artefacts and services.

5.13 Calculations involving costs of printing, second hand clothing, travel, lumber, etc.

5.14 Cattle project: calculating area, perimeter, numbers of posts, lengths of wire, weights of staples, number of head of cattle, sale of steers.

5.16 Plantation area: number of trees per hectare.

5.17 Numbers of truckloads needed for moving freight.

5.18 Cardamom project: areas, numbers of plants in a field, yield, number of workers, selling the crop.

5.19 Some standard nursing problems: how much to draw up in a syringe, number of doses in one vial, proportion of intravenous fluid run in, drops per minute.

These of course are in addition to the general business skills included in the Business Arithmetic Workbook, for example, many of which would be appropriate for clients of other Departments as well as the Department of Commerce.

This list of exercises provides an interesting attempt to identify relevant low-level applications of mathematics in Papua New Guinea. As such it is reminiscent of much good work that is being done in the West to identify similar applications that are relevant there. Typical of this movement is Burkhardt's "The Real World and Mathematics" [67]. In the Foreword he states "It is no longer obvious however that the skills learned in secondary school mathematics are being much used by most people .... Such applications as there are in school mathematics books or examinations mostly refer to highly stylized, artificial situations of little concern to the pupils who need much more help than this if they are effectively to use their mathematics in the real world".

Unfortunately what is desirable in Britain is hardly possible yet in PNG. In a country where the first school was founded barely a century ago, few numerical applications exist in the villages. The list above is not of actual applications but of desirable ones: not what villagers do (because they don't) but what extension officers have said they might be taught to do, given a calculator. At present virtually all these calculations are carried out not by the villagers but by the extension officers. (But see 4.2 below for their use in the proposed Primary School syllabus).

3.5.6 NUMERACY PROJECT STEERING GROUP

The success of this work of relating to other Government Departments was confirmed by the setting up of the Numeracy Project Steering Group on 1st December 1981. Representatives of the Department of Commerce, Community and Family Services, Education (Formal and non-Formal) and Primary Industry, unanimously approved a resolution which stated that: "We believe the promotion of numeracy skills, including use of the hand-held calculator, to be of great importance for the development of Papua New Guinea.

Our membership of this Steering Group implies the willingness of the Departments or Agencies we represent to support this work in whatever way they are able".

The specific work of the Department of Commerce has been described in 3.2, that of Non-formal Education through the Literacy Programme in 3.4 and expectations in full time education will be set out in Chapter 4.

The National Youth Movement Programme Co-ordinator was convinced that it would be possible and desirable to train Community Youth Co-ordinators and selected Youth Group Leaders in such a way that they would pass on the skills needed for the projects which were to form part of the Youth Programme. He provided copies of the Project proposals so that I could identify the skills and training that would be needed. An arrangement has been made to train a pilot group in Milne Bay Province later in 1982. Other representatives of the Department of Community and Family Services thought it most probable that a similar operation would benefit women's work, as here too the object was generally to set up small businesses or money raising projects.

The representative from the Department of Primary Industry was equally sure that a programme could be worked out through which Rural Development officers could impart appropriate skills to clients, assuming that a calculator was available and the client was prepared to use it. It is clear that good will exists with all these Departments which would permit a very flexible approach which could include both the improvement of Officers' own skills and also some further investigation and training of extension officers to pass on appropriate number skills to their clients.

Such a flexible inter-departmental policy would require a supportive base from which to operate. Up until the end of 1981 this has been provided by the Department of Commerce. From this time on however Government cuts have hit the Training Division of this Department particularly severely and some other means of providing this inter-departmental programme may be desirable. It would be difficult to persuade another Department to take on responsibility for an operation from which the specific benefits in their own field might be relatively small. The obvious answer lies in a programme funded by overseas aid, and attempts are being made currently to set up such a scheme, although it is still possible that the Commerce Department may prove willing to continue providing the base.

3.5.7 VOLUNTARY AGENCIES

Reference has been made in the Table in 3.5.2 to consultation and training of officers of the Churches. These were concerned mainly with the literacy work in which the churches co-operate with Non-Formal Education and with the training of pastors to carry out the numerical work required by their jobs.

A further example is a course prepared by Jenny Fountain of the Guala Christian Centre at Karobo (see 3.3.5.2). This will be in Pidgin; it will be based on Numeracy Project materials and it will be designed to help those who keep accounts on behalf of the Church, the Bible School, Literacy Projects, Christian Centre, medical work, and Community School. It will be basically a correspondence course but tutorials will be arranged whenever the tutor is able to visit the students who are following it. This is a very realistic approach in circumstances where communications are particularly difficult and where there are no funds to provide transport exclusively for this purpose. A copy of the circular announcing the course and the Application Form are included in Appendix 3: 6 applications had already been received in February 1982 and many more were expected.

Here therefore we have a prime example of the same agency needing training for its own workers and also being willing to pass on numeracy skills to the people. As with any other training programmes in PNG however the costs are high in that they involve travel and accommodation either of the trainers or the trainees or of both. The churches themselves would find such expenses very difficult to meet and it has been suggested that overseas funds provided through the Melanesian Council of Churches might be made available to assist such work.

The other most significant voluntary agencies in PNG would probably be those of expatriate volunteers serving in Government and other organisations with some financial support from abroad. These agencies have expressed much interest in the Numeracy Project and would no doubt be willing to provide specific volunteers to serve the cause should this prove to be an appropriate method of advancing the work.

Meanwhile it might be possible to provide some specific information about the Project for all volunteers on arrival in PNG so that they would know the sort of facilities and possibilities that existed. They could then make appropriate contacts if they came across specific needs in their work. One of the volunteer agencies, CUSO, has already started to do this.

The only other large voluntary agencies with which the Project has so far been associated have been the Women's Investment Corporations set up by the ILO/UNDP Women's Project. Mention has been made of work with these in Goroka, Madang and New Ireland (see 3.3.2 and 3.5.1) and there is a similar project in Milne Bay.

These represent a very important attempt to compensate for the extremely low status given to women in this country. The loss to PNG of the effective service of vast numbers of women is acknowledged, but little can be done quickly in such a cause. It is however important to give every support to those agencies that are working in this field and it is hoped that the Numeracy Project may continue to make its own contribution.

An attempt was made earlier to work through the National Council of Women but they were experiencing difficulties at the time and the materials then available from the Project were not very appropriate. A further offer of assistance to this and other voluntary agencies must be made as soon as the time and opportunity can be found.

3.5.8 COMMERCIAL FIRMS

Another significant type of agency for the spreading of calculator skills is the large commercial firm with its own training department. In the past employees tended to have to pick up their information on the use of the calculator from a colleague: there is now a move towards providing specific training for it.

The first such courses were given by the Numeracy Project for W R Carpenters (see 5.4) and Steamships Trading Company (see 3.2.1 and 5.5). These were followed by two courses run by Don Moore of the Department of Commerce at Laloki College in January and June 1981 for supervisors in the "big three" commercial firms, Carpenters, Steamships and Burns Philp. At each of these I was asked to give a course on the use of the calculator.

Since then Mary Edwards, as a Training Officer for Steamships has frequently provided on-the-job training in calculator skills. One particular course written by her for counter staff who have to convert between Retail Prices and Wholesale Prices, is included in Appendix 3. She was able before going on leave to teach one of their local staff to use this unit, so that newcomers could still be properly trained in her absence. The unit includes the use of the % and memory keys: the calculator used gives results correct to 2 decimal places so in this case it is desirable to work in kina.

3.5.9 THE MEDIA

Coverage had been provided by the media from the first but care has always been taken to emphasise the experimental nature of the work so far and to avoid raising false expectations.

The work has been featured in National Broadcasting Commission programmes on at least five occasions. A recording has been kept of each of them.

Broadcasts include:

1 Allen Edwards: A National programme on "Men on the Land".

2 Mary Edwards: A Morobe radio programme for women, in Pidgin (ANR 5:26)

3 A report by Bryan Wilson of the British Council after participating in one of our courses (ANR 11).

4 Mary & Allen Edwards interviewed by Beth Harding of the Education Department for Education News, October 1981.

5 Mary & Allen Edwards interviewed by Peter Zovi of the National Broadcasting Commission for PNG Magazine, on 11.11.81.

6 Allen Edwards and Mary Dickie, Assistant Secretary Training with the Department of Commerce, interviewed by Ian Boden for BBC Overseas Service.

7 Mary Dickie interviewed by Ian Boden for Radio Australia. October 1981

Articles on the Project appeared in the Papua New Guinea Post Courier:

September 1979: "Towards adult numeracy for Papua New Guinea", an article by Susan Addison expressing the concern of the Mathematics Education Centre, before the University decided to restrict the Centre's attention to a narrower field. It reported the lack of "number sense" the supplying of teaching aids to schools and the course run in conjunction with the Department of Commerce in Lae.

10.6.80: "New Shop Course" concerning the W R Carpenters Course.

13.2.81: "Another Tool for Villagers" by Susan Addison.

February 1982: "Calculators lift Numeracy". The article was an extract from the Secretary's Letter included in Appendix 1.

In the Papua New Guinea Times:

23.1.81: "Learning to Live with the number problem" by Euralia Paine

In Publications elsewhere

May 1981: "Calculator helps Villagers to learn to count by 10" by Paul Byrnes in the Sydney Herald.

May 1981: "Papua New Guinea: Calculating the way to Numeracy" by Allen Edwards in Bulletin 12 of Reading Agricultural Extension and Development Centre [68] (included in Appendix 1)

16 March 1982: "White man's magic adds up in jungle" by Anita Martin in the Coventry Evening Telegraph.

1982: An article by Allen Edwards to be included in the Courier, published by the Asian-South Pacific Bureau of Adult Education.

1982: An article by Allen Edwards and Mary Dickie to be included in the International Co-operative Alliance Bulletin No.2/82.

"Wantok" and "New Nation" from the Word Publishing Company, serving educational social and religious needs in Papua New Guinea: both considered the possibility of including an instructional series based on the Project's material, but in one case an overlapping series on trade store management had just been completed and in the other case the Project Director was not able to find time to produce the material in the form required.

3.5.10 CONCLUSIONS CONCERNING GOVERNMENT DEPARTMENTS and Other Agencies

1 The work of many Government Officers would be much improved if they could be trained to use a calculator properly.

2 Government Officers have expressed interest in helping their clients to become more self-sufficient through acquiring further numeracy skills. Materials illustrating the sort of relevant skill-training that might be given have been prepared.

3 Representatives of the Departments of Commerce, Community and Family Services, Education and Primary Industry have formally recorded their intention to assist the work in whatever way they are able.

4 A programme to train Government Officers to carry out their own numerical work more efficiently while at the same time teaching them how to pass on appropriate numeracy/calculator skills to clients, would seem likely to be a cost-effective operation.

5 Any programme endeavouring to reach out across so many inter-departmental barriers would need a supportive base from which to operate. This has been provided up until now by the Department of Commerce. Recent cuts have made it desirable to find alternative or supplementary sources of funding.

6 Cooperation with the Churches and other voluntary agencies need to be developed when the time and funds are available.

7 Instructional material could probably be developed for use with the media but time and special skills for this are not yet available.

CHAPTER 4

THE USE OF THE CALCULATOR IN FULL-TIME EDUCATION IN PAPUA NEW GUINEA

4.1 TEACHERS

The table in 3.5.2 reveals that 24 teachers and education officers were "consulted" by the Numeracy Project in 1980-81 and 441 were "trained". These figures have been separated from those of all other Government Officers because the relationship of the Project with formal education was bound to be different from that which it established with other Government Departments.

Where other Government Departments were concerned the interest lay in determining what applications of arithmetic, and particularly of the calculator, were required by the officers concerned and whether these applications could in fact be carried out by villagers given a calculator and suitable training.

With teachers however the relationship was generally different. The author could not divest himself of the fact that he had been a teacher himself for 30 years, nor could he deny that the calculator might be considered by some teachers to be a threat rather than just a useful tool.

It was therefore pleasing to find that one of the services that we were able to offer teachers was in no sense at all a threat. As in the West, many schools in PNG run "tuck shops", or rather "canteens" or "trade stores". But the teachers found it hard to run these efficiently and their superintendants were always concerned less mistakes or dishonesty should turn a potential money-raiser into a serious embarassment.

It was therefore with this brief, to help teachers to run their canteens correctly, that the author was asked to give 1½ hours training to each of four groups of 90 primary teachers one day during the National Inservice Training Week in the National Capital District (Appendix 2, ANRIO). A single sheet handout was prepared and very intensive instruction was given for the maximum time permitted, but where many teachers had never used a calculator before and where their understanding of mathematical concepts was by no means certain, it was impossible to teach everything to everyone. All four groups however showed great keenness and only one small group who had been at the other end of a 20 metre classroom full of teachers, complained they were "lost". Unfortunately it has not been possible to follow up that particular experiment but other groups of teachers who heard of it wanted similar treatment. Instead we suggested a more thorough course using the Business Arithmetic Workbook (5.12) and one of my colleagues at Laloki College kindly provided the teaching requested.

.2 THE COMMUNITY (PRIMARY) SCHOOL SYLLABUS

A more significant contact occurred when the author was invited to join the Community School Mathematics Syllabus Advisory Committee at its crucial meeting in July 1981 (see 2.3.2). He had already given some thought to the impact of the calculator on the school syllabus but was conscious that it would be useless at this stage to try to change the policy that insisted on all students learning how to manage *without* a calculator before being allowed to learn how to work *with* one.

It was however possible to suggest that a number of procedures could be taught with the calculator in mind. There was no way for example that genuine stocktaking examples could be worked out without a calculator but bearing in mind the probability that at a later stage a calculator would be available it would be very worthwhile to use simple numbers to show just how a stocktake would be carried out. Such applications would indeed in Burkhardt's words quoted in 3.5.5 be "stylized" and "artificial", but if they are clearly recognised as a way to prepare for the real problems to be solved with a calculator later then they are fully justified.

The committee at least were convinced and the following objectives were consequently added to the proposed new syllabus [58]: "The student will be able to apply the skills available to the following"

In Grade 4:

Extending and totalling invoices
Finding the total value of a collection of notes and coins
Work out a wage sheet given the wages per week or fortnight, per day or per hour
List and total the requirements for different sizes of timber for a job
Calculate the perimeter of a field, the length of wire, number of posts and the number of staples needed for fencing it
Price material given cost per metre.
Calculate the number of pieces of wood that can be cut from a given length

In Grade 5:

Weigh bags of coffee and find their total value given the price per kg
Finding and checking the successive balances in a Cash Book account
Total the columns of an analysis sheet and check the result by finding the grand total
Calculating the number of plants that can be grown in a given area, given the area required by one plant
Carry out a stocktake given that goods are placed on the shelves in piles or are in cartons
Calculate the number of pipes etc needed for a given length of pipework, rounding up when necessary

Find out how many 5 kg or 10 kg etc units he will need if he is to obtain a given weight, rounding up when required
Find the total cost of a number of whole or fractional air fares, rounding up if necessary
Price services given the times that a person has worked and the rate per hour

In Grade 6

Find the number of head of cattle that can be carried on a field given the number of head per hectare
Convert wages between fortnightly, weekly, daily, hourly and yearly rates
Calculate the cost of insurance on air freight at the rate of 1 toea or 2 toea per K2.00, rounded up
Find the cost of air freight given the rate per kg and the basic charge
Complete a leakage check form
Calculate 10%, 20%, 25%,50% or 100% of any amount up to K100.00 in relation to practical problems of the following kinds:

  Increase or decrease any amount up to K100.00 rounding up or down as required
  Price goods (without freight) given that the cartons contain no more than 10 units
  Price cooked food given certain restrictions on the quantities used
  Find the import duty on a number of items
  Calculate the Net Liquid Assets of a trade store and deduce profit or loss

All these objectives were in fact identified from studying the "ANC" exercises referred to in 3.5.5. If indeed these items are included in the new Primary Syllabus, however stylized and artificial the examples on them may be, students should have little difficulty subsequently in applying the appropriate calculator skills.

4.3 SCHOOL LEAVERS

While engaged in preparing for this syllabus review the author realised that there might here be an opportunity to get some actual calculator skills taught in the schools provided he insisted that they were only to be taught to those who were about to leave. As a substantial proportion of Grade 6 students are in fact "pushed out" by not being given High School places, the provision of a calculator skills programme for them would make a significant contribution to village life, particularly as these "push outs" generally became the best educated groups in the villages.

At this particular meeting the Committee was not willing to commit itself in this direction but it did resolve that "the possibility of including calculator-related material in the proposed Grade 6 textbook should be considered at a later date"[58].

Fortunately this resolution proved to be sufficient, since at the next meeting (Appendix 2, ANR 17) when the author reminded them of their resolution and suggested that a small research project should be undertaken to discover whether it was feasible to teach calculator skills to Grade 6 students who were about to terminate their education. The proposal was accepted almost unanimously.

The same afternoon I was invited to attend the Provincial High School Syllabus Advisory Committee as a non-member. Another substantial proportion of students are "pushed out" at the end of Grade 8, so a similar argument applied. A proposal was quickly agreed that the research project already approved by the Community School Committee should be extended to include those who were about to terminate their education in Grade 8.

By the end of Grade 10 the official view is that the students have learnt sufficient number skills to be allowed to use a calculator. Whatever one may have said about the inadequacy of those skills, the fact remained that there was no reason why calculator skills should not be taught to all students at that stage. A proposal to extend the agreed research project further to include all Grade 10 students was quickly accepted.

The Senior Curriculum Officer for Mathematics, Bob Roberts, and the Principal Research Officer, Bernard Anderson, both gave their warm personal support to the project and the author began preparing appropriate materials.

While much of the content appropriate for school leavers would be similar to that for adults the format would be quite different. For class teaching, exercise sheets would be desirable for the students and a very detailed Manual, including precise instructions as well as the answers, would be necessary for the teacher.

Such a course was prepared in January 1982 and called the Calculator Skills Pack (5.16). In addition to the usual totalling and finding change, cash book, invoice checking and pricing of goods, units were included on measurement, calculating the period between two given times, pricing services on the basis of time spent and a number of other items. A shortened version of the Pack was prepared for use in Grade 6 and possibly 8, the whole Pack being intended for use in Grade 10.

4.4 VOCATIONAL CENTRES

The Project had always received the warmest possible support from the Non-formal Education Superintendant, Barry Reeves, and he had been the first to come forward with a specific request for a course which could be used in Vocational Centres. A preliminary trial had been undertaken at the Marshall Lagoon Vocational Centre in August 1982 (ANR 13) when AND 1 and 2 (5.11) had been taught in 3 hours and 13 of the 22 trainees had bought calculators.

The next group to be taught was in Kiunga (ANR 15) where we had 21 trainees who worked successfully for a whole day, apart from 8 who did not respond well to a large adult-orientated class in which women and businessmen predominated. The following day we took another 21 trainees and this time had two staff to help so there were no problems.

The last occasion was at Menyamya when I found a group of trainees getting in the way as I was teaching an "advanced" course to some businessmen in one of their classrooms. On this occasion I gave calculators and copies of FCC1 (5.11) to one of the Centre staff, started the trainees off, gave the teacher an answer sheet and a little advice about some later examples and then left them to it. The lesson was most successful judging by the quiet hour they spent working without another word from myself. (see ANR 17).

In October/November the Superintendent invited me to a Regional Conference for about 33 Vocational Centre Managers in Lae (ANR 16) and another for about 30 in Port Moresby (ANR 17). In each case I spent an hour or so teaching totalling, finding change and the cash book and then laid out a proposal for a core course for all trainees with additional courses for carpenters, sewing classes, etc. These were approved by the Managers. They felt it should be quite possible to obtain enough calculators to teach the trainees in groups.

At the Steering Group meeting in December the Superintendent confirmed that he would like the Project to produce a package of material which hopefully would not only provide the means for teaching the trainees but would also tell the teachers how to teach it.

Vocational Centre trainees are in fact Grade 6 leavers so their core course requirements were the same as those of the school leavers referred to above in 4.3. The Calculator Skills Pack (5.16) was thus tailor made for the Vocational Centres also.

It so happened that in the great cut-back of Government funds for 1982 the Education Research Budget had been reduced to zero. The Principal Research Officer devoutly hoped that this was an accident that would shortly be put right, and this was likely to be the case, but in February he found himself unable to promise the K2000 which he had hoped to set aside to cover the cost of the School Leavers Calculator Skills Research Project. It therefore occurred to us that bringing the Vocational Centres into the same research project might have more than one advantage. This was rapidly agreed so that, at the time of writing, there is an excellent prospect that a single research scheme using the same materials throughout will establish the feasibility (or otherwise) of teaching calculator skills to those terminating their formal education at Grade 6, 8 or 10 and also to Vocational Centre trainees.

The experiment is planned for June or July 1982 and it is likely to stand or fall on two counts:

(1) can teachers in all these institutions be trained in one day to teach the course?

(2) can the practical problems involved in buying, selling and/or borrowing enough calculators for the purpose be overcome?

If the experiment succeeds and if all these institutions in fact begin teaching these calculator skills to their students before they leave, the long-term problems of the teaching of calculator skills to adults will be almost resolved.

Given that those who have not attended school can learn these skills from those who have, the dream of "making PNG numerate" could almost come true.

1.5 POST-SECONDARY INSTITUTIONS

1.5.1 LALOKI COLLEGE

During 1978 and 1979 the writer had been Director of the Mathematics Education Centre at Lae and had there studied the problem of low level arithmetical skills among entrants to post-secondary institutions ([32] see 2.2.1). In this capacity he had written a Basic Skills Course (5.1) designed primarily for the Technical Colleges but it was also being used by Schools of Nursing and some of the other Post-Secondary institutions which have proliferated in PNG.

Laloki College in its course for the Certificate in Business Management (BDO qualification) was suffering from these same remedial arithmetic problems. The author endeavoured to apply his own remedy in the form of the Basic Skills Course but encountered a good deal of student opposition to it, some students feeling it was too easy but many finding it was too hard.

At this time the cheap LCD calculator became available and it was agreed that all the students should eventually be supplied with them. The question therefore arose: should they receive them before or after the remedial arithmetic course? The argument against giving them out first was that the students would then be de-motivated from learning or revising the basic skills.

The counter to this was to enquire whether they actually needed these so called "basic skills". Obviously if they were to be able to continue with their work when their calculator was lost, broken or run down then clearly they required the manual skills. Up to the time of the advent of these new calculators the probability of their being broken or run-down was high and in the interests of safety the manual skills should be learnt. With the new calculators however, which not only had a near-infinite battery life but also had a failure rate due to faulty manufacture of under 1% (compared with 10% for an earlier model) the probability of needing the manual skills had been drastically reduced. Taken together with the cheapness of them it began to appear that one no longer needed to base the syllabus on a precaution which it was no longer necessary to take.

As an experiment therefore the students that arrived in 1981 had no basic skills revision and no commercial mathematics course either; all they were given was an introduction to the use of the calculator and the assurance that any other mathematical teaching required would be included in other topics in the curriculum at the points where the required skills were appropriate: in any case the calculator would be used for them. At the same time it was agreed that before their 2½ year course was concluded thought would be given to any specific non-calculator skills which they ought to possess. A depressing and frustrating section of the curriculum had been, provisionally at any rate, virtually eliminated.

In preparation for the 1982 intake the 1981 procedure was reviewed. While there were certain concepts and skills which various lecturers thought should be taught in a mathematical rather than a "commercial" context the overall pattern of 1981 was reported to have been satisfactory. There was no suggestion of reverting to a stress on the old manual skills before being allowed to use a calculator.

In the 1982 programme (see 5.15) therefore the original idea of starting with the calculator was confirmed and the first 26 hours of the revised "Commercial Mathematics" course would be spent on working through the Business Arithmetic Workbook, a convenient way of introducing many calculator skills. Following this there would be a course to cover a few other concepts and skills, generally those which applied to more than one of their subsequent "professional" courses. Finally a deliberate attempt would be made to show why certain arithmetical processes should still be carried out in the head without recourse to the calculator. These were desirable rather than essential but included such things as learning to give change from a kina quickly without writing anything down, a skill which appears not to be taught at primary or secondary level in PNG. (While teaching a Grade 6 class as an experiment at Kiunga (ANR 15) we found that no child in the class knew the change from K1.00 for 25t. The Community School Headmaster at Hakwange also confirmed that he would not expect his Grade 6 students to know this either (ANR 17).)

The whole effect of this change of attitude to the mathematics course at Laloki cannot be described as anything less than radical. It profoundly affected the whole approach to the subject. No longer did one base the teaching on the assumption that the calculator would not be available - and then produce it somewhat apologetically after the work had been done (and some students possibly terminated because of their failure at it).

Instead the calculator was produced as their normal tool from then on. Its use was carefully and deliberately taught instead of being dismissed in a perfunctory manner and thereafter such non-calculator skills as were considered to be desirable were justified and taught.

4.5.2 OTHER INSTITUTIONS

The surprising thing is that this revolution is appearing to take a long time to happen in other post-secondary institutions. There may be a few technical activities in which the use of a calculator is inappropriate, but I have yet to be convinced of any: I was told that calculators were not permitted on the shop floor were chocolate was being made because if one were dropped into a vat its plastic construction (unlike a screw or a nail) would make it impossible to remove the pieces. But there are no chocolate factories in PNG.

I had discussions with representatives of the Department of Health, particularly when a high proportion of candidates were being failed on account of weakness in mathematics and and I prepared some material for a group of nurses at the Port Moresby General Hospital but I was unable to convince the authorities of the general desirability of having calculators available in the ward. At another time however two nurse trainers in the Southern Highlands assured me that few of the arithmetical skills taught in the Schools of Nursing were actually needed anyway now that a very comprehensive Handbook was available. Perhaps the mathematics syllabus in the Schools of Nursing needs to be checked before decisions are made on the relevance of the calculator. (ANR 10)

The calculator is certainly appropriate for statistical work in rural health centres and superintendents of these need to be taught how to use them properly.

The Technical Colleges used various versions of the Basic Skills Course (see 5.1) and it was compulsory for all students in 1979-81. For 1982 however it was re-written once more by Grant Trewenack who had been appointed to try to solve their remedial maths problem, and was made optional. It was to be taught out of normal teaching hours and only to those who failed to reach a certain level. Other mathematical courses were written for use in connection with particular trade courses.

In 1982 however for the first time calculators were issued to all students, the same two models being chosen, one basic and one scientific, that the Numeracy Project had been using. The issue may therefore now arise as to whether or not the calculator is introduced immediately or later on. It will also be interesting to see whether the selection of "basic skills" deemed to be needed will in fact be modified by the availability of calculators.

NOTE on Chapter 5

Chapter 5 of the Thesis describes the sixteen courses produced by the Numeracy Project during 1980-82. It traces their development from a non-calculator "Basic Skills Course" written earlier and used in technical colleges, schools of nursing and other post-secondary institutions, to the Business Arithmetic Workbook, the First Calculator Course and the Calculator Skills Pack being prepared for experimental use in schools and vocational centres in July 1982.

Chapters 6 & 7 which are given in full below include references to the number skill work in schools which was the subject of Chapter 2 but which has been omitted from the present shorter version.

CHAPTER 6

RATIONALE AND CRITIQUE

6.1 RATIONALE?

So what was the rationale of four years' work in a Third World country, two years spent largely on persuading people to teach basic number skills and the other two spent persuading them to use a calculator? The two activities might appear to contradict one another.

To some extent of course they do, but it is just possible that an amalgam of the two dissimilar approaches may provide some light in an area which is now the scene of much current research.

Professor Dieudonne of France, at a South East Asia Mathematical Society Conference in Singapore in May 1979, stated: "Mathematics should not be taught for future mathematicians"[69]. He did not say: "Mathematics curricula should not be planned by mathematicians", but perhaps that is a corollary. At least let us recognise that if we have had the privilege of specialising in the subject then we shall need to be extraordinarily sensitive to the true needs of others if we are not to view them through mathematically polarised spectacles.

Wilson in a paper written for the Indian Journal of Mathematics Teaching [70] stresses the "acute and urgent" need to devise courses "to meet the real needs of the *majority* of students, rather than expect all students to follow a course originally designed for the most able, and then to call them failures when they cannot manage it".

It was a professor of engineering, J Arthur Shercliff, then at Warwick University, now at Cambridge, who said to me when I was attempt to teach only theoretical concepts of mathematics and to ignore the skills applicable to daily life.

Perhaps the author therefore may put forward the following as the principal needs of the majority, while not forgetting of course that for much of their lives the majority will be inextricably mixed with the minority and that the actual teaching programme must take account of the needs of both.

For the majority themselves the needs would seem to be primarily

A A number sense

B The ability to use a calculator

C The ability to quantify

By "number sense" I mean a combination of the skills and concepts that are appropriate to someone with a calculator in their pocket.

What skills and concepts are appropriate when a calculator is available?

1 First one needs concepts to know when to use which of the basic functions on the calculator. Addition, subtraction, multiplication, division, percentage are the principal ones. The fact that these are found on nearly every calculator suggests that these are the processes that are needed in real life: the calculator manufacturers have no doubt been researching needs for their own sakes. In teaching these concepts one must, of course, use the applications that are most relevant to the society of the day.

2 Secondly one needs the skills to carry out the processes for which one will not want to take the calculator out of one's pocket. Simple addition and subtraction, particularly subtracting from 100, multiplying and dividing by 10 or 100, perhaps doubling and halving: these are the survival skills of the late twentieth century.

appointed to my post at the University of Technology, "If you want to help engineers you must forget you are a mathematician". What applies to servicing another academic subject must apply much more strongly to the servicing of non-numerate villagers. A year's concentration on their needs may have helped a little to de-polarise the spectacles.

Most of what was done by the author in the course of four years' in Papua New Guinea was in fact empirical. It would be a rash educationist anyway who went from Britain to a Third World country with pre-conceived ideas, but perhaps sufficient time has now passed to permit the statement of certain principles, and to submit critique and experience from elsewhere to justify or dispute those principles.

6.2 MATHEMATICAL EDUCATION OF THE MAJORITY: A SUGGESTED PROGRAMME

In considering the mathematical education of the "majority" in the western world in the 20th century, eg those who did not go on to further education, one might characterise it broadly as follows:

The first quarter century: the skills of the clerk - computation

The second quarter century: the skills of the clerk, the technologist and the mathematician - computation, algebra and geometry

The third quarter century: concepts - and a tendency to decry skills

In the same broad sweeps, what could become the characteristic of the mathematical education of the majority in the last quarter of the twentieth century? Not a return simply to the skills of the Victorian clerk, though the "Back to the Basics" movement has been near to demanding this. Not a return to teaching how to manipulate complicated algebraic expressions which the majority will never require, or to the memorising of theorems in the misguided belief that this will somehow provide the majority with the capacity to think and argue as a mathematician. And in no way will the world continue to permit the expenditure of public money on a forlorn

3 Thirdly one needs the concepts and skills of estimation. These can be immensely complex and today tend to distinguish the competent from the incompetent. But they are needed by all and barely appear in the textbooks save in the form of exhortation. This surely is the area in which mathematical educational research is most urgently needed. For too long the "competent" have used their estimating ability to shame the incompetent. Both concepts and skills are required for it. The principal concepts are those of place value and range, the latter still hardly appearing in most syllabuses. The skills include some techniques for estimating addition and subtraction (and these are complex) together with a knowledge of the multiplication tables and the understanding needed to insert the correct number of zeros in multiplication and division.

By the "ability to quantify" I mean all the other concepts and skills needed in the real world, spatial understanding [71], the ability to measure distance, weight, time, capacity, temperature, angles, areas, volumes, the ability to read charts and graphs and an understanding of probability. Again, the choice of these must be related to the most probable needs of the majority whom we are considering.

Perhaps too particular techniques need to be developed for solving problems but this is an aspect of mathematical education that would still seem to have to prove its worth. One cannot but agree that solving problems is one of the principal motivations for learning mathematics, as indeed it is for other aspects of education, but one has still to be convinced that the theoretical analysis of problem solving techniques is actually going to assist the majority as distinct from the minority.

To summarise this in broad outline then, the programme that I would put forward for the teaching of the majority of our students in the final quarter of the twentieth century is this:

A Number sense: the concepts of +, -, ×, : and % and their applications in the real world, the survival skills of mental arithmetic, the concepts and skills of estimation

B The calculator, and how to use it properly

C Quantifying: measurement, graphs, probability and the rest, in so far as they are relevant to the society of the day and the place

6.3 TEACHING THE MAJORITY IN PAPUA NEW GUINEA

How do the educational programmes in PNG today compare with the suggestions I have set out above? This is of course largely what the previous five chapters of this thesis have been about, but a brief review of them may be helpful before looking at the situation elsewhere.

6.3.1 PRIMARY

In Primary Education 2.1 sets out the extent of its failure, in the eyes of the author, while 2.3 shows the hope for the future. In particular the proposed new syllabus (2.3.2) includes an impressive list of practical applications relevant to the real village life of the Papua New Guinean majority. The research referred to in 4.3 points the way to introducing the use of the calculator in relation to these applications. At present that is only being considered for those who are about to leave. What is needed here, as elsewhere in the world, is a realistic programme for using the calculator earlier in the course so that the applications can be made realistic at once instead of having to be taught in a stylised manner and only later being dealt with properly with the calculator. This however must wait until people have put aside their prejudices about the calculator so that they can use it to the full, not only in handling applications realistically but also in teaching the survival skills of mental arithmetic and the purpose and practice of estimation.

Coupled with the introduction of the calculator into, say, the fourth year of the Primary course would come the elimination of a good deal of the course that would then be unnecessary for the majority, such as long multiplication and division and most of the work on fractions. In exchange one could introduce more of the groundwork on which estimating skills can latter be based, such as the concept of the range and approximation to 1 significant figure.

6.3.2 SECONDARY

If the rationale of 6.2 were accepted the calculator would already be familiar and available throughout the course. Along with it would go the emphasis on mental skills and estimation which are its essential complement. Apart from this the concern of the High School must also be to cater for the minority and on this the author is offering no specific programme although the principles mentioned above would clearly have a radical effect on the whole of the educational system, for the minority as well as the majority and in other branches of learning such as science and the technical subjects.

6.3.3 POST-SECONDARY

The programme set out in 4.5.1 illustrates the "remedial" work that will be needed so long as these new concepts and skills are not taught at the secondary level.

If by some miracle the revolution occurred and students actually arrived at their post-secondary institutions with plenty of experience with the calculator, a good number sense and the ability to quantify distances, weight, time, etc, then the whole curriculum of every post-secondary institution in PNG could be re-written and the present disadvantages of the non-numerate culture would be largely overcome.

6.3.4 NON-FORMAL

The work in adult numeracy in Chapter 3 is of course based on the principles now being considered. Non-formal education is so much more costly per student per hour that priorities must always be most carefully considered. As will be seen the order of teaching proposed is:

1 Counting and concepts of + and -

2 Use of calculator

3 Other concepts and mental skills

If 1 and 2 could become universal in PNG the possibilities for non-formal education in the teaching of 3 would be limitless.

1.4 EXPERIENCE AND CRITIQUE FROM OUTSIDE PAPUA NEW GUINEA

If research is to be relevant to real life it is most desirable that those carrying it out should be involved as deeply as possible in that life. Indeed any other sort of research in a Third World country should be viewed with considerable suspicion. Beeby in "Teachers, Teacher Education and Research" [72] has many wise things to say in this respect. In particular he calls for research workers who

(a) have taught

(b) have worked alongside administrators

(c) can write in language a layman can understand, and

(d) have "that curious blend of assurance and humility that is so necessary in anyone who takes it upon himself to plan the lives of others"

If these are the priorities then the author trusts that he may safely leave proper analyses of these issues to research workers who are based in developed countries. The conditions under which one can work at all in a Third World country are restricted and some of their limitations to research are illustrated in 3.2.5.4. Another restriction is that so long as the research worker remains in a post which is primarily concerned with providing a service rather than a thesis, his ability to give full consideration to all the literature available on a subject is bound to be minimal.

In what follows therefore there is no attempt to review the whole of the literature on any of the topics apart from that of adult numeracy in the Third World (where the literature appears to be mercifully scarce). Throughout his work as an officer in the Department of Commerce in PNG the author has collected what papers he could (and he is particularly grateful to Bryan Wilson of The British Council and to Michael Smith of the Literacy Documentation Centre of the University of Reading for supplying many of them). What follows is a review of those papers (and a few obtained subsequently while on leave) which, in the time available, he has been able to study.

The papers are grouped under the major headings with which this thesis is concerned but these are inter-related and one critique may well refer to several different areas which have been discussed in the course of this work.

The primary interest in these lies in their application to the Third World but the author did have thirty years of experience of teaching in Britain before his four years in Papua New Guinea and he does believe that some of the lessons learned overseas, where some changes can happen quickly, may be of relevance to the "West".

The critique that follows is therefore concerned not only with the Third World. It will also make some points in relation to the West, or more particularly, to England.

6.5 CONCERNING NUMBER SKILLS IN FORMAL EDUCATION

6.5.1 INTERNATIONAL CONFERENCE ON DEVELOPING MATHEMATICS IN THIRD WORLD COUNTRIES, KHARTOUM, 1978

This Conference in Khartoum in March 1978 set down certain objectives for the teaching of mathematics at the primary level. They listed:

1 'Functional numeracy' which included place value, decimals and an appreciation of the size of the number

2 Mental attitudes to enable the development of problem-solving strategies

3 Representing and interpreting data

4 Measurement, approximation and estimation

5 Spatial concepts and the ability to draw them

[73, p 4]

These objectives clearly include what has been defined in 6.2 as 'number sense' and 'the ability to quantify'. The omission of the calculator is understandable in 1978: the cheap LCD version had yet to be produced.

The Conference deplored the habit of contrasting 'traditional' and 'new' mathematics and suggested that "the fine details of the syllabus .... is not a major problem - the proper preparation of teachers is much more important". (page 7)

The history of mathematics teaching in PNG would certainly underline the need for the proper preparation of teachers, but the gross excesses of 'logic', 'relations' and multi-base arithmetic in the syllabus, making it virtually unteachable in the circumstances, must bear much of the blame.

The Conference also recommended that "mathematicians should be encouraged to take the initiative in seeking closer co-operation with the decision-making bodies in an institutional way, in order to involve themselves in the process of formulating national priorities and to initiate joint interdisciplinary actions" (page 12). An obvious way to contribute would be to set up University-based Mathematics Education Centres with freedom to co-operate with multi-disciplinary Government agencies and so be in a position to involve themselves in the decision making processes. The experience described in 1.4 in this paper exemplifies such an arrangement admirably. Mathematicians who are willing to look at practical problems and offer realistic solutions can be assured of a warm welcome at least some of the time. When the welcome wears thin they must be able to withdraw and develop some other contact until the earlier co-operation can be restored. This underlines the need for the very broad field of operations, such as was permitted to the Mathematics Education Centre at the University of Technology in 1978 and 1979.

One other relevant recommendation was that "local mathematicians convene regularly to discuss general mathematics policy in their countries as a first step towards the co-ordination of efforts on an international scale" (page 13). The informal Mathematics Groups of Papua New Guinea as described in 2.2.1 and 2.3.1 had a practical role which provided an admirable base for general policy discussion.

6.5.2 NIGERIA AND KENYA

The disenchantment of parts of the Third World with the products of "modern mathematics" is significant. One of the strongest arguments used in the Papua New Guinean debate was the danger that continued failure to modify the effects of "modern mathematics" could result in a wholesale turn around dictated by political considerations and the loss of much that was good in that movement.

News of the dogmatic manner in which the Nigerian government had terminated the reign of "modern mathematics" in or about 1980 lent strength to the argument.

Kenya was involved from the early '60's with the American based African Mathematics Programme and from 1965 with the British based "Southampton" Mathematics Project. In August 1981 the President, Daniel Arap Moi, was reported to have "directed that the teaching of new maths should start winding up in primary and secondary schools immediately all over the country". He gave as his reason: "The new mathematics is making children slow thinkers. It is unsuitable for teaching in Kenya schools" [74].

The reference to "slow thinking" suggests that perhaps the real objection lay in the failure to teach mental arithmetic. One wonders how many good things in the development of mathematics teaching in the last two decades may now be lost because of their association with this failure to teach this most obvious of arithmetical skills.

5.3 THE POSITION PAPER OF THE NATIONAL COUNCIL OF SUPERVISORS OF MATHEMATICS, USA

Perhaps one of the most important reactions to the "Back to the Basics" trend in the United States in the '70's is this paper from the National Council of Supervisors of Mathematics (NCSM) [75].

It arose from a Conference on Basic Mathematical Skills and Learning held in Euclid, Ohio, in October 1975 at the instigation of the National Institution of Education.

Their report was discussed by the NCSM at their 1976 Annual Meeting where more than 100 participating members expressed a need for a unified position on basic mathematical skills. The Position Paper is the product of a task force set up by that meeting.

[illegible]e, the Position Paper accepts the need for teaching [illegible] skills but underlines the necessity for these [illegible]ed by other skills which are listed as [illegible] solving; applying mathematics to everyday [illegible] to the reasonableness of results; [illegible]imation; geometry; measurement; reading, [illegible]terpreting and constructing tables, charts and graphs; [illegible]edict (probability) and computer [illegible]

[illegible]mputational skills [illegible]s the Position Paper lists facility [illegible]ith addition, subtraction, multiplication and division with whole numbers and decimals. It is recognised that today "complicated computations will usually be done with a calculator", but "knowledge of single-digit number facts is essential and mental arithmetic is a valuable skill". It also acknowledges that "there are everyday situations which demand recognition of, and simple computation with, common fractions" while "the ability to recognise and use percents should be developed and maintained".

This clearly influenced the author's suggestions in 6.2 although the emphases are different: those on the calculator are more, those on fractions are less. He would also wish to see more evidence before agreeing with the need to teach problem-solving strategies involving "posing questions, analysing situations, translating results, illustrating results, drawing diagrams and using trial and error". You do not need to do all this to become an effective Papua New Guinean trade-store keeper.

6.5.4 A C BAJPAI AND R M BOND, LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

Evidence of the need for number skills in Britain is provided in an unpublished thesis written by R M Bond under the supervision of Professor A C Bajpai, "An investigation into the mathematical needs of school leavers entering craft apprenticeships and, based upon the information gained, the preparation of relevant material for use within schools" [76].

Bond carried out a survey of the opinions of 87 training officers responsible for over 6100 craft apprentices. In reply to the question "Is enough emphasis placed on mental arithmetic in schools?" 47 said "No" and 40 were "Not sure". No one said "Yes".

The subsequent success of Bajpai and Bond's "Apprentice Maths" [77] confirmed the appreciation of the need for numerical skills among those responsible for training craft apprentices. A later edition designed for use in the United States includes a section on the use of the calculator and this will appear in any further edition for use in the United Kingdom.

R L LINDSAY, SHELL MATHEMATICS CENTRE, NOTTINGHAM

Another study of the relevance of number skills to the work situation is provided by "Mathematics and Engineering, an illustrated guide to basic skills" [78] and a paper on "The Case for the 16+ School Leavers Attainment Profile of Numerical Skills" [79], both by R L Lindsay of the Shell Centre for Mathematical Education at Nottingham University. In the latter paper, which foreshadowed the successful introduction of the School Leavers Attainment Profile of Numerical Skills (SLAPONS) now administered by the Royal Society of Arts [80, p 27] Lindsay says [79, p 4]: "It is a phenomenon of 'real life' that those who had difficulty (or apathy) over problem-solving and determining whether it is 'a multiply or an add' find such decisions easy in the context of their daily work. .... But if the manipulative skills, the algorithms of arithmetic, are not ready to hand, the way is hard, frustrating and almost irretrievable without great effort on the part of apprentice and instructor". He concludes that "It would, then, seem highly appropriate to test for these numerical skills first and foremost. Those who have them are a good bet, or at least are less of a thundering nuisance!"

The lower priority here given to problem-solving is an interesting corrective to the many demands to make this a substitute for the "set theory" which at one time was acclaimed as the proper basis for all mathematical education. That is not to say that problem-solving (or set theory) is unimportant. In general life, for those who have the ability to think mathematically problem-solving may indeed be of the utmost importance. For the majority in their place of work however the variety of problems that have to be solved is relatively small and constant repetition of the same problem relieves the operative of the need for any mathematical insight at all.

One final comment however is that the "thundering nuisances" who lack numerical skills might become somewhat more acceptable if they were provided with a calculator and taught how to use it.

6.6 CONCERNING ADULT NUMERACY

6.6.1 IRAN

A great deal of literacy work appears to have been undertaken in Iran, and some of this has had a numeracy component. Sohan Singh's "Learning to read and reading to learn" [81] is no doubt relevant there. So also are Gholian's "Conception of Teaching Mathematics"in General Programmes of National Literacy Crusade [82] and a paper from the Functional Literacy Pilot Project on "The Work-oriented Adult Literacy Pilot Project in Iran" [83].

The author of course has no qualification to consider these in relation to their use in Iran. Suffice it to say that they would be quite inappropriate in Papua New Guinea.

Sohan Singh's interest in the infinity of the decimal system, for example, would certainly not be to the taste of our villagers who may not even have a genuine sense of number, let alone decimals and certainly not infinity. As has been said, even sophisticated and experienced Business Development Officers frequently write a sum of money as K3.75t, making nonsense of the whole concept of the decimal.

"In our opinion", writes Gholian, "the teaching of mathematics should not be limited just to provide an adult with the aptitude to calculate and solve the daily quantitative problems ..." [82, p 25]. In our opinion, in Papua New Guinea, that is the maximum at which we can hope to aim, initially at any rate. Our problem is rather that there are no 'daily quantitative problems'. When you have never had any means of handling certain types of problem, you will certainly have learnt to live without solving them. The problems only arise for our villagers as they seek to enter into the new and strange world of the West.

Gholian continues "... but to teach him how to think properly, understand the notion of relation, and lead him to a greater initiative in applying mathematics to various types of problems". Excellent advice no doubt in Iran and perhaps everywhere else in the world - but not in Papua New Guinea. Here one would hesitate to claim that we could teach a national to 'think properly'. After all, what do we really know of their method of thought and what right have we to judge it? The well-bred expatriate here has no such illusions of grandeur. He is paid (and if on contract, well paid) to provide the Papua New Guineans with the expertise they desire. Nothing is said on the contract about 'teaching them to think properly'.

"The Place and Role of Mathematics Teaching in Functional Literacy": the Iranian Experiment [83] is similarly inappropriate for our island. The problem-oriented approach (page 1) is indeed the method that has mostly been used in Papua New Guinea. There, however, the similarity ends: the types of problem in PNG have largely had to be dredged out from a study of what extension officers think villagers ought to have problems about, whereas in Iran the sort of problems that arise apparently involve much more difficult concepts such as speed, time, angle, proportion, and even arithmetical and geometrical progressions (page 3). We have tried to teach the clock and calendar but found any more complicated concept of time difficult; we also included a form of proportion when comparing prices of different packs of goods in a supermarket, but these are problems for government officers or town dwellers rather than for the 85% of people who still live in villages.

The author's reaction to these materials, which may indeed be suitable for Iran but are certainly not so for PNG, is to suggest that anyone concerned with adult numeracy anywhere in the Third World should carefully consider which of the now tried alternatives is most appropriate to their circumstances.

6.6.2 A FIELD EXPERIMENT IN ECUADOR

"Developing Arithmetic Skills Among Rural Villagers in Ecuador Through Non-formal Education: a Field Experiment" by Luis M Laosa describes an experiment involving the teaching of 68 adult villagers in four isolated rural communities. There were control groups totalling 33 in two other villages. [84]

In order to overcome the problem of villagers being out at work, gasoline lamps were provided by the research project to enable the teaching to take place in the evening. The non-formal educators (all Ecuadorian and in their early 20's with some post-high-school education) slept the night at the village.

In each case five weekly lessons were given, all sessions being based on a non-formal education game called Number Bingo. For this each player had a game board and a supply of markers. The game leader, one of the villagers selected by the group each time, selected a problem card at random, read it out and displayed it. The problems would consist of either sums or products and each player marked on the board what he or she thought was the answer. The boards were differently laid out and the winner was the first to complete a row of markers so there was luck as well as skill in the game. The winner's results were checked and any error would mean that the win was forfeited. Each session was preceded by a discussion of learning objectives and followed by a period of reflection, conceptualization and discussion of practical applications, their relevance to individuals' lives and proposed course of action.

Pretests and Posttests given to measure arithmetical skills included a variety of addition, subtraction, multiplication and division items from orally presented sums of two single-digit numbers to division of a three-digit number by a one-digit number on paper.

The experiment showed significant gains where the game was appropriate to the level of the villagers involved, ie, having zero or low levels of education. The most responsive village was the one with the youngest students and the lowest initial scores: Asunción with 16 students with a mean age of 20.27 (SD = 7.44), and an average of 2.40 (SD = 2.23) years of education raised their pretest mean score of 23.47 (SD = 5.11) out of 32 to a posttest score of 26.47 (SD = 3.36). By contrast Rumipamba with 12 students with a mean age of 35.58 (SD = 13.71) and an average of 4.33 (SD = 1.44) years of education raised their pretest score of 30.50 out of 32 (SD = 1.51) to a posttest score of 30.58 (SD = 1.50).

Perhaps it would be fair comment to suggest that the cost-effectiveness must have been fairly limited and would presumably be lower still if the posttest had been taken, say, 6 months later when the respondents would have had a chance to forget the number bonds they had learnt over the five weeks. On the other hand if the course could be combined with some other programme this would obviously reduce the per capita cost and make it more worth while.

6.6.3 THE TURRET BASIC ARITHMETIC COURSE FOR ADULTS, SOUTH AFRICA

The Turret Correspondence College in Johannesburg is operated by the Sached Trust and is concerned with the teaching of people for whom English is not necessarily a first language.

In February 1978 it was agreed that there was a need for an "Arithmetical Course within the Commerce Project", aimed at those with standard 2-4 education. It was appreciated that a tutor would be needed for the course and that student materials would have to be written in both English and Zulu [85].

An intial test helps to select students. It includes counting andwriting numbers up to 100, and questions: R5,00 + R8,00; R20,00 - R16,00; R1,00 - 25c; 13 + 6; 20 - 9; 14 + 5; 21 + 6; 9 - 4; 26 - 3 (the last 4 being written in column) together with two questions requiring literacy together with addition and subtraction, but these last were not considered essential for passing the test.

The Course consists of 24 lessons split into 4 units. Unit 1 covers addition of up to twelve numbers with 1, 2, 3 or 4 digits, subtraction up to 400 928 - 219 309, and applications to the payslip and bugeting.

Unit 2 covers multiplication to 713 × 29, division to 683 ÷ 19 with revision of Unit 1 and applications to working at Rate of Pay.

Unit 3 covers fractions to adding halves or thirds (not mixed), finding $\frac{2}{3}$ of R1,04, expressing 8269 : 7 as a mixed number and rounding to the nearest whole number, with applications to calculating overtime rates (at $1\frac{1}{3}$, $1\frac{1}{2}$ or $1\frac{2}{3}$) and overtime pay up to $8\frac{1}{2}$ hours at $1\frac{1}{3}$ times a basic rate of 64c an hour.

Unit 4 deals with decimals and percentages with applications to Interest and Discount and General Sales Tax.

There are tests at the end of each unit and a Final Test after another lesson on budgeting.

The Course was tested on a group of workers at Afrox Chemical Factory in the Transvaal South Africa between March and November 1978 [86]. Afrox provided a tutor and 20 male workers, mostly machine operators between the ages of 25 and 45 who were paid overtime (x $1\frac{1}{3}$) for attending. After the initial test about a third of the workers were dropped for being either "too good" or having serious reading and writing problems. 24 weekly 1-hour classes were conducted by the tutor and observed by the writer or editor of the course.

The tutor was recognised as being exceptionally good and contributed largely to the identification of weaknesses in the course where it had to be re-written. The entire session was in the vernacular but the observers felt confident that the tutor manual could be used successfully by any potential tutor if he were serious about his role.

Some students missed some lessons through no fault of their own and would have had great difficulty in catching up if the tutor had not given up lunch breaks to help them.

Most lessons were successful in themselves, only a few needing major re-writing. The testing revealed that students had difficulty in working from a diagram of a payslip but no problems with an actual one (compare 3.2.4 where it is noted that problems in a Bank Book unit were eased by making photocopies of an actual Bank Statement). It was also found that by the end of the course place value and subtraction with double borrowing had been forgotten since being done in the first unit. Revision exercises were therefore added which as the editor of the course remarks is often necessary in a written course whereas a good classroom teacher will normally do it automatically.

The greatest difficulty occurred with the fractions lessons.

After marking the final tests it was decided that not all students could be considered to have successfully mastered the course so certificates were given indicating the parts of the content that each student had mastered.

The production of the students' workbooks and tutor's manuals are excellent and anyone wishing to write such a course for their own use would be well advised to study this one. My only regret would be that this immense load of work had to be undertaken when the whole course could probably have been covered with a calculator in a quarter the time, at half the cost (including the calculator) and with four times the enjoyment!

.6.4 THE GAMBIA CO-OPERATIVE FUNCTIONAL NUMERACY PILOT PROJECT

This well-researched and thought-out project appeared at one time to be about to become one of the few Third World campaigns outside PNG concerned solely with adult numeracy. In the event however, it became part of a literacy campaign.

The Co-operative Union and the International Co-operative Alliance were already involved in literacy work in the Gambian. In the course of it the learners were consulted about their needs as they perceived them: "by far the most strongly felt specific functional need among farm household heads is to be able to understand groundnut sale transactions ... the fear of being cheated is strong ... Farmers cannot read the scales or receipts, do not understand the measures nor the few English terms employed" [87, p 7]. This indeed had a familiar ring: the corresponding problem with the sale of coffee in PNG is referred to in 3.3.2 .

Subsequently in an annexe on literacy in the same report [87, p 29] it is stated that "The reasons offered by villagers for wanting such classes were however more concerned with numeracy than literacy". In the face of such reactions and because of an unresolved problem over the use of English or a local language for literacy work it had been agreed that a decision on literacy should be postponed while an ad hoc numeracy programme was launched and pilotted in 1980 [87, p 10].

A very useful Socio-economic Background Study was produced by King in October 1979 [88] and Hans Peter Schwobel was appointed as consultant. After a full discussion shortly after his arrival it was agreed that the numeracy teaching should in practice be combined with a literacy programme. As Schwöbel stated [89, p 2] "It is possible, of course, to teach numeracy without literacy. But in the Gambian case it is useless, because all calculations to be done and all figures to be read and written by the groundnut farmers are connected to words and sentences".

The resultant numeracy course was thus only part of an ongoing literacy programme and the report on it is included in the "Evaluation of the 1980 Co-operative Pilot Literacy Project" [90].

The first primer used for the programme [91] included 9 lessons on arithmetic and the second primer 4 (judging by the Teachers' Manual, the actual primer not being available to the author). The first of these lessons introduces the numbers 1-9, the second deals with addition "for real quantities (groundnuts, etc)". In the third lesson subtraction is introduced and in the fourth the numbers are extended to 19. The next lesson introduces multiplication and requires the two-times-table to be learnt by heart. Thereafter numbers are extended to 99 and all times-tables up to 10 x 10 are to be learnt by heart. The work in the first primer concludes with subtraction involving borrowing, and division.

The second primer includes extending numbers to 1000 and the use of metric weighing scales together with a price tariff and work on taxes.

Other publications by Schwöbel which (presumably) have been used in connection with the course are "Teaching Arithmetic in the First Spiral" [92] and "Operating Arithmetic on the Flannel-Board" [93]. The former is largely a commentary on Singh [81] while the latter gives useful suggestions for teaching addition, subtraction, multiplication and division. Some difficulties however might be caused by the use of terms such as "inversion", "the symmetry of addition and subtraction", "dividend", "divisor", and "bunches" by which he means sets of relations such as 6 × 3, 20 - 2, 5 + 5 + 8, 35 - 17, etc all of which are equal to 18.

The evaluation of the Gambia Project [90] took place in June/July 1980, on classes which had begun in January or March of that year and had been held about 4 times a week by teachers resident in each area: 11 teachers and 65 students were interviewed. The students consisted of one third of each of 11 classes and were selected by the teachers.

The majority of the teachers, but only 8% of the students, replied that "writing" was the most difficult part of their literacy/numeracy teaching. Two-thirds of the students however said arithmetic was the most difficult part.

A test was given to the participants with the following results:

Questions	% correct replies
4 × 2, 3 × 4, 5 × 2	87%
3 - 2, 10 - 9	86%
9 ÷ 3, 6 ÷ 2	75%
5 + 4	82%
36 + 64, 98 - 25, 25 + 32, 10 + 20	70%

One cannot help but compare the effort implied in reaching such goals as had been set, with the rapid strides that could have been made if calculators had been available. Familiarisation with the machine might have taken three lessons, learning to use the scales a fourth, and learning to check the price paid for the groundnuts a fifth. Admittedly the knowledge of number bonds and times-tables would not have been acquired but in place of this a facility with the calculator would have been established. A major problem here may have been the poverty of the villagers, but it is noted that the estimated recurrent cost for the numeracy project alone, was £20.10 per participant [87, p 21]. Even if calculators had been provided free of charge the per capita cost would certainly have been less.

The Project Document [87, p 14] also refers to a Benin government National Literacy/Numeracy Programme which begins with practical numeracy (weighing, etc) for 10 days and calculation skills (addition and multiplication) for a further 15 days, but details of this are not available to the author.

6.6.5 LESOTHO DISTANCE TEACHING CENTRE

This distance Teaching Centre is of international renown, principally for its work in literacy. Lesotho probably has the highest literacy level in tropical Africa. One of the

Learning Games that the Centre has sponsored [94 , p 9-12] is a simple one involving two sets of cards. One set represents items that can be bought in a trade store, the other represents coins with which to buy them. An exact match has to be made between an item and a set of coins.

This sounds an excellent aid in many countries. Indeed it could well be tried out in Papua New Guinea as it would assist in the transition that is just beginning to take place in villages from a commercial system which never requires any coins smaller than 5 toea into one which uses the 1 toea and 2 toea 'coppers'. It might even convince the holders of copper coins that they were actually worth keeping, even in the villages. The value of coppers is of course already somewhat better appreciated in the towns where prices are in units, not multiples of 5 or 10.

6.6.6 JOHN GAY, NATIONAL UNIVERSITY OF LESOTHO

John Gay is the author of "The New Mathematics and an Old Culture" [4] referred to in 1.2.2. He kindly wrote personally concerning his thoughts on the use of the pocket calculator in the Third World. He is "convinced that newer technologies will bring the price down to an almost ridiculously low figure in the near future", and is fully in agreement with the principle of using it in adult numeracy work.

He also criticised the early Trade Store Management Course Units, picking up, as we did also, the complications inherent in the attempt to teach estimation. He suggests there may be local language uses of 'rounding' such as using 'three and a half pans' to imply simply that a measured quantity is more than three but less than four. With 700 languages to check it would be tedious to try to determine whether or not this is the case, though I would doubt it myself for the vast majority of languages. The time where it does occur is in the non-traditional weighing of coffee by the kilogram: most buyers 'round down' on the principle that the weight of the bag has been included. In the end, however, as explained earlier (3.3.2) the decision to sell is often based on a final price rather than on a 'per kilogram' quotation, which obviates any need for the seller to weigh or to calculate.

This particular suggestion of Gay's underlined the general point he was making in a paper prepared for the Sixth Biennial Pan-African Afrolit Society Literacy Workshop in December 1979. In this paper [95, p 9], he asserts that "competent, functioning adults in every society already know a great deal about mathematics". He may be right, and it may be that the speakers of all 700 languages in this country are anxious to explain to us expatriates just what that mathematics is. But I doubt it. Gay indeed quotes an example from Papua New Guinea [3, p 44-52] where the Kewa have a system of body-tallying which they use in relation to a pig-killing festival, but it could be that 'transfer' from this to counting anything else, let alone to trade store arithmetic, would prove to be more difficult than the learning of a new counting system. There are languages in PNG where the same number has different names depending on what is being counted, a situation which suggests that the concept of number itself is not truly formalised. The arguments have already been set out in 1.2.2. Perhaps they can be concluded by pointing out that this whole idea of 'transfer' from traditional to modern systems lay behind the highly professional Indigenous Mathematics Project, which Lancy directed. In spite of this, the Project has now come to an end and no recommendations appear to have been made along the lines that Gay has been urging.

A second letter was received from John Gay in March 1982, written in spite of the extreme pressure of other work. He had studied the Business Arithmetic Workbook and some earlier papers. He concludes that "what you have done is miles ahead of anything else I have seen, and should be shared widely".

This however followed four pages of detailed criticism and suggestion. His main concern was with the ability to estimate which he considers "central to mathematical competence". He also quoted a friend as saying that "the only really important statistical test is not chi-square or F-ratio, but is the eye-ball test".

He makes a number of suggestions for teaching students to operate the "eye-ball test". Principal among these is to include wrong answers in the workbooks every once in a while. He believes they would recognise and respond to a nonsensical answer. To some extent one can do this, and there are indeed cases of it in the Workbook which Gay himself noticed. But, sadly, my judgement is that for our particular clients in Papua New Guinea anything other than a very obvious error, pointed out immediately and explained, would cause only distress and confusion. Here of course I am thinking primarily of ordinary businessmen, but experienced Business Development Officers with whom I tried out the earlier courses in which deliberate errors were included, responded badly to them. This is not to say that the method could not be used in other parts of the world, or with advanced students in PNG where a firm teacher-student relationship had been established, but experience so far would restrict it to that.

John Gay also suggests adapting the use of the calculator to traditional games. He urges us to seek out such traditional games and model them. Again this sounds an excellent idea where the culture is sufficiently uniform to possess these features. It may be that something sufficiently widely known may be found if we do search in PNG, but my colleagues in the Mathematics Education Centre had had long experience of the country and would almost certainly have made use of such games had they existed.

An important warning given by John Gay in this letter concerns the differences between different varieties of calculator. He refers particularly to the type of calculator that evaluates products in an expression before adding the terms eg 40 ⊕ 60 ⊗ 3 ⊜ gives the same result as 60 ⊗ 3 ⊕ 40 ⊜. This is the case with the scientific calculator (Sharps EL508) which the Numeracy Project sells as a convenience to clients who particularly need it, but it does not appear to be the case with the basic machines such as the EL220 which is used in our general work.

This comment underlines the necessity for standardising the type of calculator before attempting to write instructional material. It may well be the most important factor in many situations. We were fortunate in Papua New Guinea that the markup charged by retailers (reckoned on average to be much higher than in most parts of the Third World) was sufficiently great for the Project to be able to offer a good model at about half the usual price and still make a small profit out of the sales. In such circumstances, and particularly as the classes were generally held a long way from the nearest retailer, it was safe enough to write the instructions specifically for this calculator. There was some concern when the original one went out of production but its replacement operated in an identical manner and apart from descriptions of where to find the keys, no changes to the material had to be made. It is of course possible that the manufacturers could make radical changes at anytime although they may hestitate to do this if it could lose them a near monopoly of a substantial market. If such an event does occur however, the material will have to be adapted and appropriate "conversion" units prepared, but once the habit of using a calculator is established it should not be difficult to explain such minor modifications as are likely to be required.

John Gay also picks up the usual question of why the work should be entirely in toea while the results are written in kina. This is fully dealt with in 3.2.2 : at post-secondary level of course the student should be able to use either method and understand the relationships, but our experience with new and less numerate users has abundantly confirmed our decision to avoid using the decimal point as long as possible.

The problems of "rounding" to which he also refers are associated with this decision. It is so much simpler to "leave out everything after the point" or even to "go up to the number above", than to attempt to teach what would amount to an understanding of the decimal system. The failure to understand this after 10 years of school was one of the most commonly observed phenomena in post-secondary students. Experienced businessmen writing "K3.42t" underline their failure to appreciate the meaning of "working in kina" or "working in toea". The purpose of adult education is primarily to teach what the students believe they need, and not to risk failure in this by trying to teach them something more that the teacher thinks they ought to need.

John Gay's desire to restore the teaching of approximation by "casually saying" that 48 is about 50 and 1430 about 1500 or sharing a freight cost of K20.00 between two items, must be countered by the stark reality of the group of Mothers' Union leaders referred to in 3.3.3 who actually posed the question "what should we charge for a potholder when two of them can be made from a ball of string costing K1.95". It was hard to persuade them first that K1.95 was "nearly K2.00" and second that if two did cost K2.00 then one would cost K1.00. It is extremely difficult for anyone who has never taught such people to understand how such things can be. But they are. No doubt it is different elsewhere but it is possible, perhaps, that the experience of this extreme situation could be of use in teaching some of the mathematically disadvantaged people elsewhere in the world.

Finally John Gay urges us to seek out the "network of knowledgeable village and town people" who can tell us who are the competent and outstanding shopkeepers. Perhaps we could learn from the keen store keepers who do not come to our courses. There may indeed be something in this because in the past our contacts have mainly been through Business

Development Officers who might well not be consulted by the most competent businessmen. One does however wonder how any businessmen could, for example, calculate the controlled price for a packet of soap unless they had sufficient arithmetical skills to evaluate the cost of the freight, divide by a two-digit number and add 12½%, thus giving the legally controlled maximum price. They may have learned such skills from formal education or from some expatriate or they may use the Retail Ready Reckoner but it seems unlikely that they will have any skills that will significantly replace those which a calculator can provide. This is not for a moment to say that acquiring calculator skills is either necessary or sufficient for being successful in business. It is just that it seems to help most businessmen in the West, so why should it not be allowed to do so in the Third World?

6.6.7 BRITISH TELEVISION PROGRAMMES

A number of these programmes have been used in adult numeracy work in the United Kingdom. "Numbers at Work" [96] was made by Yorkshire Television, "It Figures" [97] by the BBC and "Make it Count" [98] by the Independent Broadcasting Authority. These are not reviewed here because neither the content nor the medium is particularly relevant to adult numeracy in Papua New Guinea.

6.6.8 NORTH-SOUTH: A PROGRAMME FOR SURVIVAL

Perhaps we may conclude this section with a quotation from the Report of the Independent Commission on International Development Issues which met under the chairmanship of Willi Brandt.

"The call for appropriate technology does not prescribe any particular type; much less does it imply that the technology should not be the latest or most sophisticated... Only the developing countries themselves can decide which machines and systems will suit their own local needs... But international co-operation can help to develop new technologies and to disseminate them." [99, p 195]

In other words, let no-one decry the use of the Liquid Crystal Display electronic calculator with Auto Power Off, if that is the most appropriate tool for the villager in Papua New Guinea or elsewhere. International co-operation could indeed help to disseminate them by making sure that the lowest possible prices are passed on to the countries that need them, with as little delay as possible.

.7 CONCERNING THE USE OF THE CALCULATOR IN FULL-TIME EDUCATION

.7.1 UBIRATAN D'AMBROSIO OF BRAZIL

D'Ambrosio is President of the Inter-American Committee on Mathematical Education. A paper by him on the use of hand-held calculators in schools was published in 1978 in the International Journal of Mathematical Education in Science and Technology [100]. D'Ambrosio groups the objections to the use of hand-held calculators into three main issues:

1 Will they block reasoning and make individuals mentally slow?

2 Will their use make individuals dependent on the machine and will their absence be a handicap for daily needs?

3 Will they broaden the gaps between rich and poor and between developed and underdeveloped nations?

The author clearly has no space in a short article to deal fully with these objections, but he makes the following points in refutation of them.

He quotes Plato in "Phaedrus" where the invention of writing is denounced by King Thamus of Egypt as a danger to civilisation: children and young people who used to apply themselves to learn and retain whatever was taught would now cease to exercise their memories and consequently be less diligent and capable, said the King. The human race seems to have come to terms with the use of writing: it is reasonable to assume it will also come to terms with the pocket calculator.

At a humbler level d'Ambrosio remembers being forbidden to use ball-point pens (and I remember having to forbid students to use them) on the grounds that handwriting would be so spoiled as to become illegible. There are more powerful reasons for legibility than the inconvenience of dip-pens: so there are better reasons for mental arithmetic than the need to use it in paper-and-pencil algorithms.

D'Ambrosio also stresses the need for 'quantitative common-sense', which has a similar meaning to my 'number sense'. Where precision is required the calculator is there to give it, but the very fact that it is so easy to produce this accuracy may encourage people instead to give a 'reasonable quantitative result'. The important thing is to be able to combine 'number sense' with 'ability to calculate'.

The President of an Inter-American Committee is in a good position to comment on the relevance of the calculator to the problems of social imbalance and global inequality. The only effective way, he says, to challenge these destructive elements is to provide whole generations of 'have-nots' with the abilities and tools possessed by the 'haves'.

He refers to the young Peruvian boy who, after much effort, learns how to do arithmetic with pencil and paper. He then goes for a job in the city and sees the boss merely pressing a few buttons to get the same results. The lad is immediately 'put down': had he been taught to use a calculator, he would not have been.

Finally, d'Ambrosio refers to the immense new power to use realistic numbers in modelling real problems. This alone should be a sufficient justification for making the use of the calculator universal in mathematical education.

7.2 PAM HARRIS, MATHEMATICS IN ABORIGINAL SCHOOLS, AUSTRALIA

Pam Harris was in the Curriculum and Research Branch of the Department of Education, Northern Territories, Darwin before being appointed Project Officer for the Mathematics in Aboriginal Schools Project.

In May 1978 she presented a paper on 'Measurement in Tribal Aboriginal Communities' [101] to the Second Annual Conference of the Mathematics Education Research Group of Australia. This took as its starting point a national survey conducted by the Australian Council for Educational Research in October 1975. This survey aimed at assessing the number of children who were failing to attain the basic skills of reading, writing and numeration. It also sought to specify relationships between these attainments and various other factors including ethnic origin.

In their final report published in 1977 [102] one chapter was devoted to the comparative performances of aboriginal students. The conclusion was drawn that "the overall performance of students in aboriginal schools in the Northern Territory on the tasks set in the Reading and Numeration Tests was very low indeed".

Examples of this were given, such as the following test results:

Description of Test Item	% Correct	
	Aboriginal students in the Northern Territory	Australia overall
(Students aged 10 years)		
Addition of 5 coins totalling 37 ¢	17	97
Calculating the cost of 3 articles costing 25¢ each	6	90
Write down the time (11.35) shown on a watch face which has Arabic numerals	2	71

(Students aged 14 years)		
Calculating change from $1	20	95
Recognising the lowest cost per article of 5 differently sized packages	2	69
Write down the time (4.40) shown on a watch face that has strokes only	3	89

In her paper Pam Harris shows just how irrelevant some of the mathematics taught in primary schools is in remote communities where the children speak an Aboriginal language most of the time.

Questions were asked to discover the availability and use of abstract terms such as 'length' and 'weight'. It was clear from the replies that apart from time and money, such abstract terms do not exist in Aboriginal languages. This however did not mean they could not discuss such problems. Objects would normally be measured by comparing them with what would have been expected in the circumstances, or by imprecise references to English measurement terminology.

The terms used for money were not always helpful: more than half the respondents reported the use of a word meaning "stone". Few of the terms used gave any indication of the value of the coin or note. In many places copper coins were referred to as "the brown ones" and silver ones as "the white ones". 1¢ and 2¢ coins were almost unknown to many Aboriginal children. They were usually thrown away.

In conclusion Pam Harris suggests that "a measurement programme prepared for white English speaking school children living in an urban situation is unlikely to be appropriate for introducing the study of measurement to Aboriginal children living in remote tribal communities".

She recommends that a programme of research aimed at developing appropriate mathematics curricula should be set up immediately.

In association with Bill Ryan, Pam Harris presented a paper "Teaching Mathematics in Aboriginal Schools" to the National Conference for Teachers of Aboriginal Children in September 1978 [103]. It attempts to draw some attention to the areas in which the ability of the Australian Aborigines is in fact superior to that of white Australians. She refers to their skill with the boomerang and their ability to identify accurately the directions of distant places even after a long and circuitous chase in the desert.

The writers also quote a method of body-tallying which enables Aborigines to count up to 30, in contrast to the maximum of four or five which Australian folklore asserts as their limit. Skill in card-playing is also referred to as evidence of mathematical ability.

Their recommendations include the following:

"Rather than attempting to force children onto formal work early in the primary school, a period of one or perhaps two years should be devoted to kindergarten-type activities. The majority of these children commence school with very limited pre-number experience and therefore need a greatly extended readiness programme."

"The importance of activities with money or token money should not be overlooked. These activities maintain high interest, give valuable experience in handling money and provide number experience in 'real life' situations."

"Measurement activities should form a large part of the mathematics programme. It is important however that children be given the necessary prerequisites before launching into measurement using standard units. These prerequisite experiences should form part of the early kindergarten-type course."

"In schools where the mathematics course consists of rote learning of the four processes and drilling of basic facts it is evident that attitudes to mathematics are poor and children's concentration spans appear very short. This approach is considered inappropriate."

The writers also quote results of a survey of Aboriginal education in Western Australia [104] which included the following:

"The four processes with whole numbers were generally not mastered, however most pupils were able to demonstrate intuitive understanding using concrete material such as Multi-base Arithmetic Blocks."

"The idea of reversing addition and subtraction, multiplication and division, was in most cases retarded."

"The level of success and enjoyment in activities involving money or token money was much higher than in more abstract activities."

"Most texts and workbooks available were considered inappropriate for children with language or literacy problems."

The revised Western Australian Primary Mathematics Syllabus was subsequently recommended for use in both Urban and Aboriginal schools in the Northern Territories in 1980. An in-service programme was initiated in which the publication of a lively and well-produced primary mathematics newsletter "Sumthink" [105] played a part.

Much in this brief review of Aboriginal Education is indeed relevant to Papua New Guinea. Similarities include the low performance in standard "Western" tests of numeration and such details as the idea that small 1¢ and 2¢ coins are worthless.

The main difference lies in the fact that the whole curriculum in PNG is supposed to be concerned with students from such cultures, while the Aborigines represent only a small minority concern in Australia and do not yet have their own curriculum.

It is not the purpose of this thesis to study the whole area of mathematical education in these societies. It is concerned primarily with number skills and the application of the calculator. On this basis the author would therefore, with much deference, make the following suggestions:

1 If the community life currently involves so little numeracy is it not perhaps wasteful to put too much effort into teaching them number skills that involve a substantial amount of memory work? If they are not going to be used frequently they will be forgotten anyway.

2 An alternative to this would be to introduce the calculator as early as possible, perhaps as soon as the ability to count forwards and backwards has been assured.

3 Subsequent teaching of number-skills could be based on the assumption that a calculator was available. Estimation and approximation would be emphasised.

4 The principal application of mathematics would be to money.

5 The teaching of all forms of measurement would assist in the concepts of continuity and range which are essential if estimation and approximation are to be understood and practised.

.7.3 CALCULATORS IN THE PRIMARY SCHOOL, NORTHERN TERRITORIES, AUSTRALIA

This article by F J Meredith of Jingili Primary School illustrates some of the experimental work being done in Australia in 1980 [106].

He emphasises the dangers that might arise from excessive use of the calculator: failure to develop non-calculator computational skills, lack of understanding of the mathematical principles involved, inability to evaluate or question the accuracy of their answers.

Meredith's school purchased five Dataman Programmed Calculators for use in years 1 to 3. These are similar to the "Quizkids" that were sold through the Mathematics Education Centre at Lae in 1979 (**See** 1.4.4) : the machine produces the questions and the answers have to be entered. The Dataman could be programmed by the teachers to test particular types of number-fact questions required. (Information on such machines is provided in "Calculators for Kids" by Gribbin J & M [107]).

Use was found to be effective and enjoyable operation methods being picked up quickly.

Ordinary calculators were also experimented with in the upper primary classes. Various games were played and the teachers agreed that they could be used effectively for:

Survival skills for children needing remedial programmes
Developing problem solving skills
Self-correction of written exercises
Experimentation leading to concept development
Creating number patterns

6.7.4 ROLF HEDRÉN OF SWEDEN

In Sweden the Board of Education has set up a committee to analyse the consequences of the introduction of the hand-held calculator. One of its teams works in the upper primary school: its chairman is Rolf Hedrén of Falun-Borlänge. His article on "Hand calculators and maths in primary schools" was published in the UNESCO Quarterly Review of Education in 1979 [108]. He has also kindly provided a summary of results of tests carried out with experimental and control groups in form 4 during the school year 1979-80.

Hedrén recognises that the elimination of pencil-and-paper algorithms would substantially reduce practice in simple number skills but he does not consider that this is sufficient justification for the estimated 50% of teaching time devoted to such algorithms. Instead her urges increased training in mental arithmetic *per se*.

He has also urged increased training in estimation, but, like others, has found this by no means easy or popular with the students. Even after considerably more practice in it than was provided for the control groups, the experimental classes achieved only a slightly better result. Hedrén's comment on this [109] was that students might not be so frightened if they were taught to round off more roughly, as was explicit for example in my Basic Skills course. It is also significant that rounding off 'to the nearest' is a much less common practice in real life than it is in schools. In commerce there is a tendency to round up or down according to quite other criteria, usually those of ease or profit. In Sweden students are even being taught to round 25 down to 20 but 35 up to 40, so that the last given digit after the rounding off is even. One wonders how much further one could remove school mathematics from the ordinary world. A general rule to round down would seem to be much more realistic. It could be followed, perhaps at the secondary level, with a study of the effects of such rounding, particularly, as Hedrén's committee suggests, in cases where further calculations are made following rounding. But the whole teaching of estimation is clearly worthy of further research and experiment.

The main emphasis in Hedrén's work, however, lies in the use of the calculator to facilitate the construction and solution of realistic word-problems. In spite of this he concludes that "it is easier for the students to grasp the idea behind a problem when the numbers involved are uncomplicated" [110]. There is no doubt that teaching in this field also requires much more research but the experience so far does seem to support the suggestion in 4.2 that artificially simplified numbers in word-problems should precede the introduction of real-life examples.

Hedrén is convinced that the results so far obtained "clearly indicate that hand calculators can be and will be introduced in schools as early as upper primary school".

.7.5 LILA BENTAL, BARNET, UK

Ms Bental is author of the NFER "Essential Mathematics Test" and Teachers' Guide [111]. She is also a member of the Child

Guidance Remedial Service of the London Borough of Barnet. In a letter commenting on the similarities between the problems of teaching villagers and non-numerate city children, she agreed with an approach through the use of money and considered that this was probably one of the most fruitful ways of approaching the learning of arithmetic concepts, process and language.

She expressed the common concern about the dangers of misusing calculators and producing wrong answers. She emphasised therefore the value of estimating and approximating but appreciated that this was a "challenge". In spite of her doubts she had in fact suggested to her own colleagues that the calculator should be introduced to younger remedial pupils instead of leaving it till the fourth year of the secondary school. She was subsequently pleased to note that the Cockcroft Report had recommended the use of calculators extensively at least throughout the secondary level (See 6.7.6).

6.7.6 THE COCKCROFT REPORT, ENGLAND AND WALES

This report is of such importance for the future of mathematical education that one can only regret that the timing of this thesis has meant that it was practically complete before a copy of the Report [80] became available to the author.

In studying its comments on number skills and the use of calculators the author was however pleased to note that there is considerable agreement with his own views previously expressed. Differences are largely accounted for by the differences between the situations in Britain and Papua New Guinea. It is hoped that putting these views side by side may be of help in both countries and perhaps also elsewhere. The method adopted here therefore will be to quote passages from the Report and to comment on them either on the basis of their relevance to Papua New Guinea or on the basis of the author's own previous experience in Britain.

1 "Since there appeared to have been very little research carried out to identify the mathematical needs of adults, we decided ... to commission a small study to be carried out ..." (page 5)

It is pleasing to observe that PNG in effect commissioned such a study through the Numeracy Project in 1980-81. The difference however is that in PNG many of the needs have to be presumed whereas in Britain they can be observed (See 3.5.5).

2 "We felt that such an investigation would be of use to both bodies because although the problems and methods of teaching adults are different from those of teaching children, an understanding of the goals to be achieved should be of value both to those who teach adults and to teachers in schools" (page 5).

The direct incorporation of much of the experience gained by the Numeracy Project in the revised Primary syllabus proposed for PNG is a clear example of this (See 4.2).

3 "This apparently widespread perception amongst adults of mathematics as a daunting subject pervaded a great deal of the sample selection; half of the people approached as being appropriate for inclusion in the sample refused to take part." (page 6)

This is a quotation from the study referred to in 1 above [12]. It must act as a warning of the long-term effects of allowing mathematics to become a "daunting" subject in school. It underlines the urgency of dealing with this problem in PNG (See 2.1).

4 "... some felt that there should always be an exact answer to questions involving mathematics and so found themselves in difficulties when it became necessary to approximate or round off a result. 'I get lost on long sums and never know what to do with the "leftovers"?' 'My mind boggles at the arithmetic in estimation'." (page 8)

The inability of the Mothers' Union group in Popondeta (See 3.3.3) to relate K1.95 to K2.00 illustrates this. There would seem to be two important means of overcoming this misconception of mathematics as being always exact: a concentration on measurement (See6.7.2(5)) and on the use of the calculator with its necessity for rounding.

5 "... a widespread inability to understand percentages" (page 8).

If they are not understood after so many years of formal education it could be that a new approach would help: little would be lost if it did not. The calculator makes it easy to calculate percentages and also the effects of increasing or decreasing by given percentages. Perhaps frequent use of these, without the trauma of manipulating fractions, would in fact help the understanding.

In his "Relational Understanding and Instrumental Understanding" [13] Skemp distinguishes these two types of understanding. However, as the Cockcroft Report comments (page 68) "mathematical understanding is not 'all or nothing'". Familiarity with the results could lead to a better "understanding" than what is in effect an "instrumental understanding" dependent on the use of a particular set of algorithms for calculating it. The "minority" may well be able to see beyond these algorithms to a full relational understanding, but clearly the "majority" cannot. Some sort of understanding provided by much practical use facilitated by a calculator may be far better than no understanding at all.

6 "About 70 per cent of those interviewed ... had access to a calculator if they required it but one-third of them said that they never used one. Some of the latter admitted that they did not know how to use a calculator and others expressed doubt and distrust. 'I never use it because of the risk of major mistakes.' There were also those who maintained that 'brains are better' or

that 'they make you lazy'. Some who had tried to use a calculator had been discouraged by the large number of figures which had appeared after the decimal point ... On the other hand there were some, whose computational skills were weak, for whom the use of a calculator made all the difference. 'I know the theory but without the calculator I couldn't do it.'"

This quotation states so well many things the author has been struggling to assert.

Calculators are very widely accessible: so education *must* take account of them.

Some do not know how to use one: teaching *is* needed.

"The risk of mistakes", "brains are better", "they make you lazy": are three classic objections any advocate of calculators will meet. All, one suspects, are compounded with a large proportion of prejudice.

"discouraged by the large number of figures which appeared after the decimal point": the use of toea rather than kina was partly to offset that danger (See 3.2.2). A first approach which simply says "the part after the point is only a 'bit'" can be followed later by a more sophisticated understanding where some of these figures are significant.

"... some whose computational skills were weak, for whom the use of a calculator made all the difference": this could apply to practically every Papua New Guinean and perhaps even a majority of Britons. So why indeed should the calculator not be allowed to "make all the difference" for them?

"I know the theory but without the calculator I couldn't do it": 'knowing the theory'is not true of the average Papua New Guinean even if it is of most Britons.

So what does one do if the theory is not known and if one cannot teach it, either for lack of time (eg in non-formal education) or for lack of ability in the student? Does one just give up and say "too bad for them"? Or does one accept what appears to be the only alternative, teach the skill without the theory, ie rely on "instrumental" rather than "relational" understanding. In doing so one accepts the probable loss of long-term memory over it, but if it is something that will be used frequently that does not matter.

This then is the justification for much of the approach used in the Numeracy Project: there was no hope of teaching the "theory" so we just taught the "practice" and accepted the fact that if what was taught was not used, then the process would be forgotten. This is why we had grave doubts about teaching the many women who could not expect to be able to apply their knowledge at once. In their case the justification was different (See 3.3.5): even if all the skills were to be forgotten some tiny gain in "conscientization" was considered worthwhile.

7 "... some people appear to use practically no mathematics because they have organised their lives so as to avoid its use ..." (page 10): this is the basic cultural situation from which one starts in Papua New Guinea so we can sympathise and might even be in a position to appreciate their problems better because of it.

8 "... we would include among the mathematical needs of adult life the ability to read numbers and count, to tell the time, to pay for purchases and to give change, to weigh and measure, to understand straightforward timetables and simple graphs and charts, and to carry out any necessary calculations associated with these ... as a necessary accompaniment to this list which we have given it is important to have the feeling for number which permits sensible estimation and approximation..."

This applies almost word for word to Papua New Guinea: it is a good check list for the Community School there as indeed it must be for the secondary schools here. There is no excuse for falling down on these things even if the only way to achieve them is to teach everyone to use a calculator.

9 "We would wish the word 'numerate' to imply the possession of two attributes. The first of these is an "at-homeness' with numbers and an ability to make use of mathematical skills which enables an individual to cope with the practical mathematical demands of his everyday life. The second is an ability to have some appreciation and understanding of information which is presented in mathematical terms, for instance in graphs, charts or tables or by reference to percentage increase or decrease" (page 11). This admirable definition should be widely accepted although the author might personally prefer Girlings "Numeracy is the ability to make intelligent use of a hand-held calculator" [114]. Its application however will of course depend on what everyday life demands and what information is presented in mathematical terms. These are far less in PNG than in the UK, but education there must look ahead to the probable demands and presentations of the next twenty years. This must be a minimum aim for formal education and perhaps a maximum aim for a "Numeracy Project".

10 "Although fractions are still widely used within engineering and some other craft work these are almost always fractions whose denominators are included in the sequence 2, 4, 8, ..., 64. ... The need to perform operations such as $\frac{2}{5} + \frac{3}{7}$ does not normally arise, and manipulation of fractions of the kind which is commonly practised in the classroom is hardly ever carried out. In the rare instances in which it is necessary to multiply or divide fractions, it is usual to convert each to a decimal before performing the operation, if necessary with the help of a calculator." (page 21-22). This applies even more so to Papua New Guinea

where metrication is virtually complete and even the first sentence in the quotation does not apply. Coupling this with the desperate need for other mathematical skills in PNG there really seems now an unanswerable case for the limitation of fractions even in High Schools to using them to express division and to converting them to decimals.

It has always been to the author's regret that John Hayter who wrote an admirable report on the teaching of mathematics in High Schools failed (in the author's view) to grasp this nettle [115 p 29]. He admitted that retaining the topic was difficult to justify on the grounds of use but he refrained from recommending any change for fear of "undermining the teachers' confidence".

11 "One of the more surprising results of the studies is the explicit use which is made of algebra. Formulae are widely used by technicians, craftsmen, clerical workers and some operatives but all that is usually required is the substitution of numbers in these formulae and perhaps the use of a calculator .... Formulae are also used regularly in nursing. An example quoted in the report of the Nottingham study is: Child's dose $= \frac{\text{Age x Adult dose}}{\text{Age + 12}}$. It is not normally necessary to transform a formula; any form which is likely to be required will be available or can be looked up. Nor is it necessary to remove brackets, simplify expressions or solve simultaneous or quadratic equations, although algebra of this kind is sometimes encountered on courses at further education colleges. Solution of linear equations is required very occasionally." (page 22). So here we have another candidate if we are looking for something to replace by more relevant mathematics. All we need is a calculator and teaching how to use it. The formula quoted cannot be carried out without the use of the memory or one of the other techniques which can be taught but are rarely discovered otherwise. Given this the whole of algebra other than substitution could be moved to the post-secondary field where it could be taught as required to those who needed it.

12 "Industry and commerce rely extensively on the ability to estimate" (page 22). This, as the report says, includes both the ability to judge whether the result of a calculation is correct and also to make subjective judgements about a variety of measures. This is of course vitally important, particularly if we are to make a greater use of the calculator. Unfortunately as Hayter points out in the report quoted above [115 p.39], "In various parts of the world discussions on basic skills in mathematics frequently lead to the listing of 'the ability to estimate' amongst the essential skills ...

"General approval appears often to have been sufficient as a case for inclusion, without I feel a close analysis of what such skills involve. For teachers, educators and practioners in the field of mathematics there is little doubt about the use they make and the value they place on estimation ... What is not so obvious is:

i The method by which they estimate

ii the variety of estimation methods which they as individuals use

iii the time and the way in which they learned to estimate

iv the mathematical ability of those who choose to use estimation.

My hunch is that most of us come to estimation at a relatively late stage and at a time when we have gained some confidence in our ability to do the computation by the precise method. Further, I suggest that the methods or algorithms we use are often created for our own purpose, often for a particular task which is encountered with some frequency. Estimation is hence a "friend" to be used and not a "foreigner" to be learned and related to our own framework of knowledge. Finally I suspect that estimation is a skill used by relatively sophisticated users of mathematics except where, for instance, a craftsman uses a narrow range of estimation skills, which are probably used with startling precision!"

All this should be carefully noted by anyone rash enough to urge the teaching of this type of estimation, that of judging the correctness of a calculation. If however it means that many such skills have to be left till post-grade 10 work (as I would advocate) the concepts, such as the 1-significant figure range, could well be taught much earlier at the Primary level and related to the second method of estimating, that of making subjective judgements. For the Papua New Guinea trade storekeeper, this may well have to suffice. He should be able to judge whether the price he calculates is likely to be about right. For the rest he must simply learn to check his calculations.

The Committee believe that estimation is "an area in which further study is required" (page 77). This has already been strongly urged in 6.2(3) above.

13 "It is of fundamental importance - and we believe, not as self-evident as some might suppose - to appreciate the fact that all the mathematics which is used at work is related directly to specific and often limited tasks which soon become familiar" (page 24). This is probably even more true in PNG than in Britain. It is our justification for teaching skills when we lack the opportunity successfully to teach concepts (see 5.10).

14 "There are certainly some things in mathematics which need to be learned by heart but we do not believe that is should ever be necessary in the teaching of mathematics to commit things to memory without at the same time seeking to develop a proper understanding of the mathematics to which they relate." (page 70).

"Ever" is a strong word, modified only by the word "seeking". In particular if you know well that some or even all of the students in your class are most unlikely ever to "develop a proper understanding" of a particular topic does this quotation mean that you must never teach it "by rote"? Or can one salve one's conscience, but probably harm the teaching, by offering an "explanation" which one knows they will not understand? I suppose there may be some mathematics teachers who have never said "you won't understand this now but you may do one day and it's true anyway", or words to that effect! There really is no need to understand how a calculator works any more than it is to understand the chemistry which explains how a pencil writes. Most people who learn statistics have to accept formulae without understanding the mathematics on which they are based.

The criterion is surely that we reduce such occasions to the minimum, but we must accept that there are situations when it is right to base the teaching on faith in the teacher rather than on an understanding of the mathematics. In other words, syllabuses need not be totally determined by the desirability of 100% understanding prior to learning. If other considerations make it desirable to learn the multiplication tables while some or perhaps many, of the students do not really understand their relationship to the addition tables, then so be it. The issue may sound pedantic but such principles can make or break a syllabus, and have indeed contributed to the disaster of the unrevised "MaCS" syllabus (see 2.3.1).

15 "We believe the decline of mental and oral work within the mathematics classrooms represents a failure to recognise the central place which working "done in the head" occupies throughout mathematics" (page 75). The frequency with which mental work has been urged in this thesis should make the author's agreement with this quotation abundantly clear.

16 "An excessive concentration on the purely mechanical skills of arithmetic for their own sake will not assist the development of understanding in these other areas. It follows that the results of a "back to basics" approach (as we understand the words) are most unlikely to be those which its proponents wish to see, and we can in no way

support or recommend an approach of this kind"(page 80).

The author would wholeheartedly agree. Unfortunately discussion has sometimes been so polarised that anyone urging that increased attention should be paid to number skills was automatically assumed to be part of a "back to basics movement. It is largely thanks to Bob Roberts, the Senior Curriculum Officer in Mathematics for PNG, that such misconceptions have now largely been overcome there. The new spirit of cooperation was referred to by Lancy in an address to a joint meeting of the four Mathematics Groups in 1979 [116]. The price of compromise may have been paid but dialogue and agreeing to differ seem to have produced the desired fruits in the end.

17 "It is therefore essential that children should be helped to attain a secure and rapid recall of addition facts up to 10 + 10 and the related subtraction facts, and of multiplication facts up to 10 x 10 and the related division facts .... Learning needs to be based on understanding, but understanding does not necessarily result in remembering." (page 87)

Such specific requirements have now been written into the proposed revised MaCS (primary school maths syllabus) in PNG, but not before it was time. (see 2.3.2)

18 "The development of general strategies directed towards problem solving ... can start during the primary years ... Not a great deal is yet known about the ways in which these processes develop nor are suitable materials for the teachers readily available." (page 94) The warning should deter any enthusiastic band-wagon jumper in the Third World from instant incorporation of problem solving strategies into the syllabus. It is a piece of research and experiment which the author feels can better be left to the developed countries where it is easier to pick up the pieces of shattered illusions. This, he believes, does not apply with the same force to the early introduction of the

calculator where the lack of numeracy in the culture makes it a matter of greater importance and urgency in PNG than in Britain.

19 "The increasing availability of electronic calculators has made it all the more important that, in the teaching of low-attaining children attention should be given to the development of concepts and applications. Once these are understood, it becomes possible to make use of a calculator to overcome lack of computational skill, but a calculator can be of no assistance until a child knows which arithmetical operation it is necessary to carry out" (page 99).

At first sight this might be viewed as a warning not to introduce the calculator too early. On the other hand the number of applications which are meaningful to a child are limited, particularly of course in Papua New Guinea. Teaching them which operation to use is then a fairly limited task, and what better way than plenty of practice on the few applications that are relevant? In any case the majority of applications there probably only require + or - , concepts which are not really difficult to teach. The concepts of x and : are far more difficult but it hardly seems right to postpone tackling such problems until after the concepts are established. As it must frequently be remembered, understanding is as likely to follow practice as it is to precede it. Being told what operations to use on one occasion does not hinder and may indeed help a child to ultimately acquire enough understanding to determine the matter for himself or herself. The argument in (14) above surely applies here: you indeed "seek" to give understanding but for the many (in PNG) who will never really "understand" x and ÷ , those who cannot understand may have to be told.

20 "From all the studies the weight of evidence is strong that the use of calculators has not produced any adverse effect on basic computational ability" (page 110). This refers particularly to the considerable number of research projects that have been carried out in the United States. It answers the common "they make you lazy" reaction quoted in (6) above.

21 "'Calculators have revolutionised computation and barely numerate students can overcome their weaknesses with these'" (page 110). This is a quoation from a submission to the committee but it happens to be so apt to the content of this thesis that perhaps it is a good one on which to conclude these references to the Cockcroft Report. Anyone wishing to consider the matter further should read Chapter 7 of the Report itself.

6.7.7. THE SPODE GROUP. a Schools Council project

These have been one of the groups of teachers in Britain trying to relate mathematics more closely to real life [117]. According to a report in the Education Guardian of 23 March 1982 [118] their recommendations include the splitting of schools mathematics teaching into two distinct courses, one concerned with practical mathematics, "mental arithmetic, percentages, fractions, graphical representations, the 24-hour clock and other simple mathematical ideas, while an additional but optional course would be available to put those keen enough to try it in touch with the more imaginative and artistic kind of mathematics".

The idea is not new of course but the circumstance are. The old "arithmetic only" examinations lacked status and required a fairly good facility in compution. A new "Basic Mathematics" course which could be shown to provide all the skills needed for life or normal employment might be able to overcome the credibility gap and be fully accepted. If the standard demanded for the "imaginative and artistic" mathematics students were set sufficiently high, the basic one would have to be accepted.

It is only to be regretted that administrative problems in PNG would make such an arrangement in the High Schools very difficult but in reality it is only the "Basic" one that is needed there. "Imaginative and artistic" mathematics at that level might be encouraged informally and could become the main constituent of the "major" Grades 11 and 12 mathematics course in the four National High Schools.

6.7.8 ELECTRONIC CALCULATION IN THE ELEMENTARY MATHEMATICS CURRICULUM

This report [119] by C A Gregory, surveys recent developments in the stated field in the U.S.A.

The National Council of Teachers of Mathematics (NCTM) recognised the calculator's potential in September 1974 but failed to identify the real issues.

The National Advisory Committee on Mathematical Education (NACOME) published an analysis of school mathematics in 1975 [120] in which they suggested a decreased emphasis on manipulative skills and an increased emphasis on estimation/ approximation. It also proposed that at the end of Grade 8 calculators should be provided for all students including those who are not "functional" with numbers, for use in all mathematical work, including tests.

It also identified basic questions on when and how calculators might be best introduced, how they would affect children's grasp of basic facts, when paper and pencil calculations would still be necessary, what calculator designs might be optimal and how calculator use in the early years might affect High School mathematics. The need for curricular revision was noted.

Still in 1975 the National Institute of Education (NIE) conference at Euclid [121] (already referred to in 6.5.3) called for research into "true functional needs", the potential of calculators for learning and long range effects of their use.

A National Science Foundation (NSF) Report [122] analysed the role of the calculator and beliefs about its role. In the Introduction Marilyn Suydam summarised the arguments cited for and against calculator use.

The Case for

1 Aid to computation
2 Facilitate understanding and concept development
3 Lessen the need for memorisation

4 Help in problem solving
5 Motivate children
6 Aid in exploring, understanding and learning algorithmic processes
7 Encourage discovery, exploration and creativity
8 They exist.

The only real question was how they should best be used.

The Case against

1 They are substitutes for developing computational skills
2 They are not available to all
3 They give a false impression of Mathematics - it may be equated with computation
4 They will be misused by teachers and students
5 They are faddish - there has been little planning or research
6 They may present maintenance and security problems

Suggestions for Research were also made:

1 When and how should they be introduced?
2 Procedures for learning?
3 Calculator algorithms?
4 Long-term effects of use?
5 Effects on curricular sequence and emphasis?
6 Relationship between work with calculators and computers?
7 Changes in teacher education curricula?
8 Optimal designs for calculators?

It was strongly recommended that restructuring the curriculum, and research, should proceed hand in hand.

Gregory in his report [119] from which this information is taken maintains that all the major issues were raised in one or other of these four reports. In the United Kingdom, he says that there had been little general awareness of the extent and depth of the Americal literature and that much of the writing in British journals was relatively fragmented and incoherent.

The current research and development has been summarised recently [123 ,124 and 125]. Virtually all studies so far have been "experiments" carried out in the United States using control groups.

In spite of the recommendations of the principal reports referred to earlier hardly any curriculum materials designed for calculator use have been employed. More than half of the 100 studies reported up to 1980 have been adjudged inadequate in design or execution. There is little doubt however that the calculator is being "more intensively researched than any other comparable teaching aid".

Furthermore, there were, according to Gregory, a number of curriculum projects being undertaken ranging from "the cautious (Philadelphia [126]), through the rather more ambitious and experimental (Northern Iowa Problem Solving Project [127]) to a few which have attempted to base learning on the calculator itself (Oregon [128]".

In Britain there have been two main projects, one set up by the Schools Council in Durham, following a feasibility study carried out there in 1973-6 [129] and the other in Nottingham sponsored by the Shell Centre and Leicestershire LEA which will be referred to in greater detail in 6.7.12.

The Mathematical Associations Computers and Calculators Sub-Committee and the Schools Calculator Working Party which meet three times a year at the Shell Centre (6.7.11) provide opportunities for exchange of ideas while the Calculator Information Centre at The Ohio State University does this in America.

Gregory also provides an interesting historical backgound. Between the 13th and 16th centuries there was continuing debate between "abacists" (in the Universities) who favoured the use of the abacus with Roman numerals, and "algorists" (mainly merchants) who usedthe Hindu-Arabic numerals and sought to "free man from a machine" [130].

When in the 16th century the algorists succeeded in their aim through the use of decimals they promptly started the search for faster and easier computation which led eventually to the calculating machines of Babbage and Odhner.

Hopkins however [131] has argued that both calculating machines and paper-and-pencel algorithms are equally calculating devices. This surely is true, the algorithm providing the student with little more genuine insight into the operation than does the machine.

The significance of this history therefore lies in the assistance that it may give in overcoming some of the prejudice that exists concerning the calculator: the paper-and-pencil phase was merely an interlude between the use of one type of machine and another, it was better than the abacus but not as good as the calculator.

6.7.9 CALCULATOR EXPLORATION FOR CONCEPT REINFORCEMENT

This is the title of an article by David Johnson of Chelsea College [132]. Perhaps it may stand for the many papers currently being produced in the field.

It makes use of a set of exercises in which each box represents a missing digit or operation, for example:

Find the missing digits in:

93 x 8 ☐ = 8 ☐ ☐ 1

7 x (☐ 8 - 2 ☐) = 112

Find the missing operation in:

(37 ○ 21) ○ 223 = 1000

6975 ○ (36 ○ 39) = 93

As Johnson points out the activity provides plenty of variety for children of differing ability, practice in single-digit basic facts, inverse operations, place value and estimation. Correct answers are apparent: once a solution has been found the calculator checks it immediately. It is possible to create exercises at any level from early primary to late secondary. The students could even be asked to create their own problems, when they will have to deal with questions of alternative solutions.

This is but one example of many. Perhaps this type of activity is the one through which most development will come. Such an informal unstructured approach however may be less appropriate in the Third World where teachers are less inclined to use their own initiative.

.7.10 COUNTDOWN TO MATHEMATICS: OPEN UNIVERSITY

This book [B3] is introduced as a sample of the use of the calculator that one will expect to find in texts today: it happens to be produced for the Open University but its style seems likely to be copied.

A scientific calculator is used throughout the work. Specific instructions for it are given on 40 of the 61 pages covering the first module. These are concerned with estimating, negative numbers, use of brackets, decimals, scientific notation, accuracy, fractions, percent, reciprocals, squares, and square roots.

.7.11 THE SHELL CENTRE FOR MATHEMATICAL EDUCATION, University of Nottingham

A visit to the Shell Centre is probably the quickest way in which anyone in Britain could find the answer to enquiries about the use of calculators in schools. An Information Pack was available in March 1982 including the following:

1 "The Case for Calculators: ammunition for arguments." Thirteen examples are given of objections to the use of the calculator, many of which I have heard in Papua New Guinea. The answers are helpful.

2 "How to run a calculator conference", "Notes on discussion starters" and "Some Calculator Questions". These were no doubt produced in connection with the Schools Calculator Working Party referred to in 6.7.8.

3 "Calculators in Public Examinations" is in draft form providing information about the uses permitted in GCE and CSE examinations.

4 "Choosing a Calculator" by Ken Tyler, which begins by emphasising the importance of the LCD calculator.

5 A paper headed "Towards a definition of Basic Numeracy" (see [114]) in which M S Girling starts by pointing out that a cheap calculator can now be bought for the price of two good cabbages. It goes on to emphasise the need for checking answers, mental work, techniques of approximation, scientific notation and the investigation of pattern in numbers.

6 "Calculated Risks", [123] see 6.7.8, is an article in the Times Educational Supplement in which Barry Blakely looks at some of the research into calculator usage.

7 "The Calculator - an imperative in Secondary School" by P Kaner [134] illustrates its potential for concept - teaching in trigonometry, square roots and compound interest.

8 A report from the Institute of Mathematics and its Applications (IMA) Working Group on Curriculum Development and Dissemination: this includes a suggestion that calculators should be introduced to children by the age of 9, and possibly as early as 7. This would agree with the author's own suggestion for introducing them in Papua New Guinea as soon as students can count, and understand what is meant by addition and subtraction (7.3.5). Their mathematical knowledge at that age in PNG will be far less than in Britain but so is the extent of functional numeracy that the majority will ultimately require. If there are only a handful of applications that are likely to be relevant to their life in the village the broad mathematical base that one wishes to provide in Britain might be better left to a later stage. In 1976 and 1977 nearly 20 000 students dropped out of primary education after only two years or less [12 , p.224]. Is there not a case for ensuring that such children do at least return to their villages with a knowledge of the calculator on which non-formal education could later build? Such a suggestion would of course require much research if it were to be considered seriously, but the impact of the calculator is so radical that no alternative should be dismissed without being given due consideration. This is research which would have to be carried out in Papua New Guinea: the conditions in the western world are totally different.

9 A report from the IMA Working Group on "The Content of Mathematics - What should be Retained, What should Go and What should be Added" [135].Here the importance of teaching efficient calculator use was stressed, and the desirability of retaining mental skills which might be lost if calculators were always available.

10 "Calculators: Promising Practices in the Teaching of Mathematics (including current and needed research)". [124] see 6.7.8. Here F R Watson of the University of Keele points out that "the effect of the calculator is likely to be more profound and may be greater even than that of the curriculum reforms of the 1960's"because whereas teachers were free to take or leave "modern mathematics", the calculator cannot be ignored. It is here. It is even in Papua New Guinea. Watson goes on to suggest various uses suited to the secondary school.

11 A report from the IMA Working Group on "Numeracy in a Calculator Age" [135] referred to strong arguments for retaining vulgar fractions in school teaching, but these were based on the continued use of Imperial measures in Britain. It also referred to claims that "the use of a calculator could enlarge the numerical vocabulary and broaden the mathematical horizons of pupils in all age and ability ranges, though some doubts were raised at the too-early introduction of calculators in infant classrooms". The Group was clearly divided in its views.

12 A report on the IMA Working Party on "Teacher Training" [135] urged research on the best use of calculators in schools. Some members with experience in the primary section felt that simple calculators "should be an essential part of the apparatus available in primary schools".

13 "The Calculator Mathematics Curriculum of the Future" [136]. Here Blakely redefines numeracy as basic to the curriculum and adds four new areas: estimation and reasonableness of results, errors, algorithms and procedures, modelling. He considers the SMP Books A to H and X, Y, Z [137] and proposes the following deletions: slide rule, log and trig tables, fractions to any depth, linear programming, latitude and longitude, the matrices transformations link. These would remove 22 out of the 124 chapters.

14 "Calculators in Mathematics" by Peter New [138] describes the phenomenal development since October 1971 when the first hand-held four-function calculator appeared at £79.95. As he says "The time scale of development has been breathtaking compared with the evolution of either the motor car or the aeroplane."

15 "Calculators in the Classroom" by Alistair McIntosh answers some practical questions [139].

16 "72 x 49" by Chris Jones describes a lesson forming part of the Durham Junior Calculator Pilot Study [140].

17 "Personal Calculators and Mathematics" [141] is the submission to the Cockroft Committee from the Schools Calculators Working Party. It discusses the use of the calculator as a calculating aid in applications in mathematics and other subjects, its various uses as a teaching aid in the current mathematics curriculum and the wider changes that will gradually follow from its introduction.

18 "Calculators: Abuses and Uses" by David C Johnson of Chelsea [142] His "abuses" include Calculations for no apparent purpose, games and puzzles with no apparent mathematical objective, "Mystical button pushing" in which he includes the practice of "making words by turning your calculator upside down" and checking answers which have been obtained by pencil-and-paper methods. Under "uses" he includes Calculations, Patterns, Estimation, Errors, Algorithms, Iterative procedures, Mathematical modelling, Exploration for concept-demonstration, concept-reinforcement and problem-solving and Applications to consumer and social needs.

19 "Using Square Roots" by William Wynne Willson of Birmingham [143]. Willson describes how the $\sqrt{\ }$ key on a simple calculator can be used to evaluate, by iterative processes, cube roots, trigonometrical functions, logarithms, exponentials and inverse trigonometrical functions.

20 "Fractions by calculator" by the same author [144].

A "reasonably easy and natural" way to deal with fractions on the calculator is explained.

21 "Iowa Problem Solving Project" by John Torr, manager of the project. This lists (in October 1979) 18 instructional modules on Problem Solving, of which two are on the calculator and two on calculator codes.

22 Two useful booklists, one from the Mathematical Association Teaching Committee (Calculators sub-committee) and the other of the Shell Centre's own publications complete this most useful package of materials.

23 The work of the Shell/Leicestershire Primary School Calculator Project is described in the next section.

6.7.12 KEN TYLER, THE SHELL/LEICESTERSHIRE PRIMARY SCHOOL CALCULATOR PROJECT

This project, sponsored by the Shell Centre and the Leicestershire Local Education Authority started in 1979 and has developed materials in association with 13 Primary Schools. A very eirenic approach was used, striving to overcome teacher prejudice and avoiding any appearance of laying down the law.

Most of the teachers concerned now accept that the calculator can help in the formation and development of number bonds and place value. Some children who had long been "failures" had found fresh motivation. Enthusiasm has been retained by children who have been using the calculator in these ways for the past three years.

Ken Tyler himself was a member of staff of one of the Primary Schools that had been involved in "A Calculator Experiment in a Primary School" [145] in 1978 which paved the way for the current project.

The main product of the Project's work has been "Calculators in the Primary School, A Short Course on the Role of the Calculator in Primary Mathematics". This workbook is to be published in June 1982 by the Mathematics Education Research Group of the Open University. A second draft was issued in 1981 but I was able to study what was virtually a final version.[146].

The introduction explains that the workbook is to be used alongside the existing mathematics scheme, developing and reinforcing number bonds and encouraging mental arithmetic. Tyler suggest that in practice it is unnecessary to "teach" the children how to use the calculator: they generally find out quickly for themselves as part of the learning process.

The first exercise on addition consists of filling in missing numbers in 3+ ☐ =10 for example and checking with the calculator. Place value with two digit numbers is also revised. The work must be shown to the teacher before the page is turned. Reinforcement is provided on the back of the sheet. Then the student has to forecast the results of additions, and check with the calculator.

Subtraction is dealt with similarly. Multiplication is gradually built up from multiplying by 10, by multiples of 10, by 100, then multiplying two multiples of 10 and treating groups of products like 8 x 2, 80 x 2, 8 x 20, 80 x 20. In all these the calculator is used only to check the work.

Division is treated on 10 sheets, in some of which the calculator is used to obtain the answers, in others only as a check. A range for the answers has to be found in the last four sheets.

Other groups of worksheets tackle the following:

Using the calculator (relating addition to multiplication)
Decimal fractions
Place Value (14 sheets on this)
Number chains
Multiplication patterns
Number patterns
Number grids
Missing keys (18 sheets)
Targets
Estimation (7 sheets)
Reading numbers
Trial and Error
Problems
Money

Games are also described in Teachers Notes, for example:

"Reading numbers" where one partner reads out the numbers given in words on the sheet, the other enters them into the calculator and presses ⊕ after each one. They compare this final sum with the "check number" provided.

"Arithmetrick" is a game for two players using cards with numbers 0 to 20. Each time a card is turned over the player must try to enter an operation which will produce the number on the card from the number that was there before. If the player succeeds he keeps the card.

"Space Invaders": this consists of entering a 3 or 4-digit number, say 1352. These digits are the "aliens" and have to be "shot down" by entering ⊖ 2 ⊜, ⊖ 50 ⊜, ⊖ 300 ⊜ ⊖ 1000 ⊜. In a second version the aliens have to be shot down in ascending order by ⊖ 2 ⊜, ⊖ 300 ⊜ etc. A third version requires them to be shot down by addition: ⊕ 4 ⊜, ⊕ 60 ⊜ ⊕ 200 ⊜ ⊕ 8000 ⊜. A fourth version introduces a decimal point into the original number.

This is the result of three years of practical experimentation. Only eleven years after the introduction of the four-function calculator to Britain (at £79.95), this is a remarkable achievement. It leaves one wondering what mathematics teaching will be like in another eleven years. Will this be the mark of mathematical education for the majority in the last quarter of the 20th century?

CHAPTER 7

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 SUMMARY

We have observed causes and effects of innumeracy in adults and have shown how the calculator can be used to meet the needs of Papua New Guinean businessmen.

We have pointed to the potential of the cheap long-battery-life calculator for universal numeracy and we have outlined relevant programmes needed to achieve this objective through formal and non-formal education.

All that remains for us to do here is to specify these programmes more precisely and to suggest what further research is required to fulfil them.

The conclusions and recommendations which follow are based on the work in Papua New Guinea coupled with thirty years previous teaching experience in England. They obviously cannot be expected to be applicable in every detail everywhere but they are offered as a basis on which to work.

Those which specifically refer to Papua New Guinea are in section 7.5 but even these may have applications elsewhere.

References in parentheses are to *some* relevant sections of the text.

7.2 CONCLUSIONS AND RECOMMENDATIONS CONCERNING ADULT NUMERACY

7.2.1 THE NEED

1 The demand for numeracy teaching may well be greater than the demand for literacy (See 2.3.3, 6.6.2).

2 Without a calculator worth-while numeracy is virtually unteachable to adults (See 3.4.1).

3 Using a calculator, numeracy is reasonably cheap and easy to teach provided the participant "knows his numbers" (See 3.4.1).

4 Everyone seeking numeracy and able to buy or borrow a calculator, should, if possible, receive appropriate training.

7.2.2 DISADVANTAGED GROUPS

Particular consideration should be given to the possibility of providing calculator-skill training for disadvantaged groups within the community (See 1.1.7, 6.7.1)

7.2.3 STANDARDISING CALCULATORS

If detailed instructions on the use of a calculator are necessary it is most desirable to standardise the model for which they are to be written, (see 6.6.6).

7.2.4 THE LCD CALCULATOR

Where a power supply is lacking and spare batteries may not be readily available, a reliable calculator with a long battery life is essential. In 1982 this points to the use of an LCD (Liquid Crystal Display) calculator (See 3.1.3,6.6.8, 6.7.11(4)).

.2.5 SALE OF CALCULATORS

One way to standardise calculators is to arrange for them to be imported and re-sold at a price substantially below the normal retail prices (See 3.1.3, 6.6.6).

2.6 CUSTOMS DUTY

Customs Duty should not be charged on cheap LCD hand-held calculators.

7.2.7 PRE-CONSIDERATIONS

Any decisions concerning a possible Adult Numeracy programme should be based on the following considerations:

1 The current level of numeracy (see 6.7.6(1).

2 The likely motivation for improvement (see 6.7.6(2).

3 The possibility of making a standard calculator available at an attractive price.

4 The willingness of voluntary and statutory agencies and their officers to participate in such a programme.

5 The possibility of setting up an Adult Numeracy Unit (See 7.2.8).

6 The possible relationship of adult numeracy teaching to traditional mathematical concepts and activities, (see 6.6.6, 6.7.2).

7.2.8 ADULT NUMERACY UNIT

A small Unit able to co-ordinate an Adult Numeracy Programme would require:

1 Staff with appropriate expertise in training and preparing materials and a willingness to adapt to new situations.

2 Facilities for selling calculators and other materials as required (See 3.2.4).

3 Facilities for typing, copying, printing and graphics production.

4 Funds to permit trialling of new materials under appropriate conditions and generally monitoring the Programme (See 3.2.7).

5 Built-in relationships with Government and other agencies having staff able to assist in the actual training of participants.

6 Good public relations.

7.2.9 ORDER OF ATTACK (See 3.4.1, 5.10, 5.13, 6.6.3, 6.6.4, 6.6.6)

In adult numeracy the starting point must depend on the level of the students. In general the order of attack will be:

1 Reading and writing "Western" numbers, and counting forwards and backwards.

2 Understanding the concepts of addition and subtraction.

3 Learning to add simple numbers using the fingers or other concrete aids.

4 Learning to use the calculator for simple processes such as totalling cash, finding change and keeping a cash book, including the use of the 'clear' and 'clear entry' keys (See 3.2.4) and the need to check results. (see 6.7.6(6)).

5 Learning the composition of 10 and finding "change from 100" mentally, using the constant function on the calculator to practise these skills.

6 Meeting other specific needs of the students with or without the calculator.

7.2.10 OTHER SKILLS (See 3.2.5.2, 3.3.4, 3.5.5., 5.10, 6.6.1, 6.7.2)

Other skills for which teaching is likely to be required in a Third World country include:

1 Use of scales to weigh commodities for sale.

2 Finding total value given price per kg.

3 Checking invoices.

4 Pricing goods purchased in bulk given the freight costs and the % markup.

5 Finding the % markup given the cost and selling price (See 3.2.3).

6 Pricing products based on the "batch", eg, cooked foods.

7 Pricing sewing, duplicating, etc, where the cost has both fixed and variable elements.

8 Measuring, comparing, totalling, differencing, multiplying, dividing and estimating lengths.

9 Listing and pricing timber requirements for construction of furniture, etc.

10 Telling the time and finding what it will be in 1, 2, 3, ½ or 1½ hours, (to keep the work simple).

11 Calculating the period between two given times and pricing services based on this.

12 Reading a calendar and finding the date in so many days, weeks, fortnights, months or years.

13 Finding the number of days between two given dates.

14 "USE BY" dating on perishable articles.

15 Cross-totalling.

16 Totalling money with a "notes and coins slip".

17 Calculating wages at "time", "time and a half", etc.

18 Completing, checking and correcting a wages sheet.

19 Stocktaking (See 3.2.5.2).

20 Calculating leakage in a trade store (See 3.2.4).

21 Calculating profit in any business (See 3.2.4).

22 Comparing prices of different sized packs of similar goods.

23 Deducting a discount.

24 Calculating interest.

25 Keeping a cheque account.

26 Calculating the perimeter of a field and the number of posts, length of wire, weight of staples needed to fence it.

27 Finding the area of a field and calculating results dependent on this.

28 Finding a page or hymn number by comparing numbers (without a calculator).

29 Use of the constant function on the calculator for the conversion of units, scaling of marks, etc.

2.11 MATERIALS

Materials required are likely to include:

1 Simple, reliable, hand-held calculators with long battery life (See 3.1.3, 3.2.7).

2 Workbooks with full instructions that can be used on a one-to-one basis by personnel who are neither trained teachers nor experienced in the work (See 3.2.4, 3.2.7, 5.12).

3 Exercise sheets containing the same questions as are in the one-to-one materials but intended for use in groups, and omitting most of the instructions (See 3.2.4).

4 Exercise sheets suitable for use by trained and experienced operators (See 3.3.4, 3.3.6, 4.3, 4.4, 5.11, 5.16).

5 "Cartoon posters" or "memo sheets" to remind the students of key processes they have learnt (See 3.2.4, 3.2.7)

6 Numeral cards and "snap" cards for teaching number facts.

7 Various games including those based on progressing along a route with numbered squares, with instructions for using the calculator in place of dice (See 5.10, 6.6.5, 6.6.6).

8. Metre rules, preferably marked in centimetres and labelled .01, .02, ..., .99 (see 5.10).
9. Clock faces with movable hands.
10. Scales for weighing in kg.
11. Exercise sheets with full instructions available if required for the tasks listed in 7.2.9.

7.2.12 ESTIMATING AND CHECKING

Estimation and approximation are difficult skills to teach, particularly to students with poor number skills. Checking of calculator results should therefore normally be either built into the procedures taught or should be done by repeating the calculation (See 3.2.2, 5.2, 5.3, 5.4, 5.5, 5.6, 5.8, 5.9, 5.15, 6.2.(3), 6.6.6, 6.7.2, 6.7.4, 6.7.5, 6.7.6.).

7.2.13 AVOIDING THE DECIMAL POINT

Adult numeracy work should not assume an understanding of decimals if it can be avoided, although it may be hoped that such understanding may develop in time. Where possible therefore calculations involving two units (eg kina and toea or dollars and cents) should normally be carried out on the calculator in the smaller units, leaving it to the user to insert the decimal point in the answer when necessary (See 3.2.1, 3.2.2, 5.5 6.6.6).

7.2.14 MEASUREMENT

1. Measurement for general purposes should be expressed in whole centimetres, whole metres or in metres to 2 decimal places, thus providing numbers in the same format as for money. More specialised treatment requiring millimetres should be expressed in whole mm, whole metres, or in metres to 3 decimal places.
2. The teaching of skills and concepts of measurement can make an important contribution to the concepts of estimation and approximation (See 6.7.2, 6.7.6(4)).

2.15 LITERACY PROGRAMMES

Every literacy programme should have a numeracy programme associated with it if desired by the participants (See 3.4, 5.13, 6.6.4).

7.3 CONCLUSIONS AND RECOMMENDATIONS CONCERNING FORMAL EDUCATION

7.3.1 LACK OF NUMBER SKILLS

Inadequate number skill teaching in Primary and Secondary schools leads to uneconomic remedial work having to be done in post-secondary institutions (See 2.2, 5.7, 6.5.2).

7.3.2 CHANGES OF SYLLABUS

Changes in syllabus must be accompanied by appropriate supplies of materials and adequate in-service training (See 2.1).

7.3.3 TECHNICAL & COMMERCIAL EDUCATION (See 4.5, 5.7, 5.15, 6.3.3)

In technical and commercial education the order of attack in mathematics teaching should normally be:

1 The use of the calculator including clear, clear entry, percentage and memory keys, using relevant examples.

2 Non-calculator number skill work needed for estimation or other specific purposes (assuming a calculator will always be available).

3 Other calculator and non-calculator concepts and skills as and when required for specific tasks related to the course including a proper understanding of the use of decimals (See 6.6.6).

.3.4 SECONDARY EDUCATION

In Secondary education the use of calculators should be taught at the beginning of the course. They should then be used throughout for concept development and to enable realistic problems to be solved without undue time being spent on computation (See 6.7.1, 6.7.8, 6.7.11)

7.3.5 PARTIALLY NUMERATE CULTURES

In cultures where the applications of numeracy are sparse the calculator should be introduced as early as possible in Primary schools to reduce the waste of time on learning number facts and algorithms which will subsequently be forgotten through lack of use (See 6.3.1, 6.6.1, 6.7.2, 6.7.6(7, 18, 19), 6.7.11(8)).

7.3.6 MATHEMATICS FOR THE MAJORITY

The mathematics syllabus for the "majority", from the Primary level onwards should concentrate on:

1 The use of the calculator (See 6.2, 6.5.3, 6.5.4, 6.5.5, 6.7.3, 6.7.4, 6.7.6, 6.7.8, 6.7.10, 6.7.11, 6.7.12)

2 Mental arithmetic including multiplying and dividing by simple multiples of powers of 10, ranges, rounding up, down or to the nearest, methods of approximation and estimation (See 2.3.2, 6.2, 6.5.1, 6.5.2, 6.5.3, 6.5.4, 6.5.5, 6.6.6, 6.7.4, 6.7.5, 6.7.6, 6.7.8, 6.7.12)

3 Other mathematical concepts and skills having relevance to daily life (See 1.3.1, 3.5.5, 4.2, 6.1, 6.2, 6.3.1, 6.3.2, 6.5.1, 6.5.3, 6.7.6, 6.7.7)

7.3.7 REDUCTION OF SYLLABUS

Time spent on activities which are better tackled with a calculator should be reduced or eliminated, particularly long division (See 6.7.6(11), 6.7.11(9, 13)).

7.3.8 SCHOOL LEAVERS

If the use of the calculator cannot be included in the general educational programme it should at least be taught to all students before they terminate their formal education (See 4.3, 6.7.11(8)).

7.3.9 MATHEMATICS EDUCATION GROUPS

Informal groups of mathematics teachers can make a valuable contribution (See 2.2.3, 2.3.1, 6.5.1, 6.7.6(16)).

1. They should be independent of the Education Department but supported by it.
2. The Group should co-operate responsibly in preparing materials, criticising proposed materials and assisting with in-service training.
3. The responsible Curriculum Officer should undertake always to respond to any formal proposition from a Group, whether agreeing with it or not.

7.4 GENERAL CONCLUSIONS AND RECOMMENDATIONS

7.4.1 UNDERSTANDING AND LEARNING

Where, for good reasons, it is not possible or appropriate to teach the understanding of mathematical concepts and skills, it may be good and right to teach only the actual skills needed, without "understanding" (See 5.10, 6.7.6(5, 6, 13, 14, 17, 19)).

7.4.2 MATHEMATICS AT WORK

The numbers of different mathematical processes that ordinary workers have to carry out in the course of their jobs are relatively few (See 6.5.5, 6.7.6(13)).

7.4.3 SELF-PACED LEARNING

Fully self-paced teaching materials which require a significant amount of explanation in words are generally only appropriate for well-motivated, reasonably able students with a good grasp of the language (See 5.1, 5.2, 5.6, 5.8, 5.15, 6.6.3, 6.6.6).

.4.4 METRICATION TO AID THE DISADVANTAGED

The pace of metrication should be reviewed in the light of the needs of the mathematically disadvantaged. Where these form a substantial proportion of the population a case may be made for accelerating the metrication process so as to reduce the extent and variety of their mathematical needs.

Such considerations for example might point to the elimination of the half-penny from the British monetary system.

7.4.5 MATHEMATICS EDUCATION CENTRES

1 The setting up of a Mathematics Education Centre related to a university should be mainly concerned with making the facilities and expertise of the university available to users elsewhere in the country (See 1.4.4, 1.4.5,6.5.1).

2 Any such Centre should not be considered primarily as a means of servicing/that university or carrying out work for which its Mathematics Department is properly responsible (See 1.1.2, 1.4.3; 1.4.5).

3 The broader its permitted field of operation the more cost-effective it is likely to be, assuming that wise choices can be made of the particular forms of assistance it should offer (See 1.4.4, 6.5.1).

4 It could make an ideal base for an Adult Numeracy project provided its staff were appropriately oriented and sufficiently closely associated with Business Development (See 1.4.4).

7.4.6 RESEARCH IN THE THIRD WORLD

If research is being paid for from the resources of the Third World its cost-effectiveness must always be borne in mind. In general such research should be carried out by people involved in the work and in close touch with the administrators. It should be written up if possible in a language that the political decision-makers can understand (See 6.4, 6.6.2).

7.5 CONCLUSIONS AND RECOMMENDATIONS SPECIFIC TO PAPUA NEW GUINEA BUT POSSIBLY RELEVANT ELSEWHERE

7.5.1 TRADITIONAL NUMBERING SYSTEMS

The traditional mathematical concepts in PNG are minimal, diverse and in most parts of the country so quickly being forgotten that it is in general unprofitable to try to relate current to traditional usage (See 1.2.2, 3.4.1, 6.6.6).

7.5.2 BUSINESSMEN'S NEEDS

The vast majority of businessmen have inadequate number skills (See 3.1.1, 3.1.2, 3.2).

7.5.3 BUSINESSMEN'S RESPONSE

Businessmen respond well to being taught to use a calculator but will probably need to use one for simple purposes for a considerable time before being ready to learn and remember the more sophisticated processes (See 3.2).

7.5.4 WOMEN

Women should be taught calculator skills to assist in their "conscientization" even if there is no immediate prospect of their being able to use the skills (See 3.3.2, 3.3.5.1, 3.3.6, 3.5.7, 6.7.6(6)).

7.5.5 GENERAL MOTIVATION

The only uses of the calculator that are generally relevant and appreciated everywhere are:

1 Totalling cash

2 Calculating change

3 Operating a cash book

(See 3.3.1, 3.3.6)

7.5.6 TRADESTORE KEEPERS

All trade store keepers should, in addition to the items in 7.5.8, be taught:
1 Invoice checking
2 Pricing as appropriate
3 Stocktaking
4 Determining leakage (See 3.2.3)
5 Nett liquid assets (See 3.2.4)

7.5.7 ADULT NUMERACY UNIT

The present Numeracy Project forms an adequate base for an Adult Numeracy Unit as described in 7.2.8:

1 The Director and at least one other professional staff member should be free to carry out the programme full-time.

2 The present flexible arrangements with Laloki College for the provision of calculators and other materials are very satisfactory (See 3.2.7).

3 Typing, copying and printing present no problems and graphics are done by Kirsten Karanfilovic by courtesy of the ILO/UNDP Project for Small-Scale Enterprises and Entrepreneurship in the South Pacific (See 3.2.4), but arrangements for enlarging and reducing graphics by the Department of Education Printery are tenuous.

4 The principal trialling costs have now been covered and some further expenses may be included in training costs which it is hoped may be paid by other Departments involved. Additional funds would however assist in more rapid development of the Programme, particularly in work with voluntary agencies (See 3.1.4, 3.5.7, 3.5.10).

5 The Numeracy Project Steering Group appears to be working well as a co-ordinating agency with other Departments and good relations exist with the many government officers contacted largely because they appreciated both being consulted and being provided with calculator-skill training themselves (See 3.5).

6 The media have always responded well to information received from the Project (See 3.5.9).

7.5.8 MATERIALS FOR ADULT NUMERACY

With reference to those listed in 7.2.11:

1 The Sharps EL220 calculator as supplied by the Numeracy Project is suitable (See 3.2.7).

2 The workbooks should be in English (as in the Business Arithmetic Workbooks) since most potential trainees understand it and Pidgin is not a good language for giving precise instructions (See 3.2.4, 3.2.7, 5.12).

3 Exercise sheets for use with the Workbooks should be in Pidgin (at the time of writing these have still to be prepared).

4 The First Calculator Course (FCC) and the Calculator Skills Pack are suitable for use by experienced operators eg teachers (See 3.3.4, 3.3.6, 4.3.4.4, 5.11, 5.16).

5 Cartoon posters in Pidgin are required (funding for them was still in doubt in February 1982) (See 3.2.4, 3.2.7).

6 The numeral and "snap" cards as prepared for TEMLAB are suitable.

7 The "Sum-ten" and "Car Race" games are suitable (See 5.10).

8 Metre rules as supplied by the Numeracy Project are suitable (see 5.10).

9 Clockfaces are produced by the Department of Education and should be used when this part of the programme becomes operational.

10 Scales for weighing coffee etc can usually be borrowed when required.

11 The "ANC" series of exercises (See 5.10) will need continual updating as needs are expressed.

.5.9 RESEARCH IN PNG

The difficulty of communication means that formal verification of research hypotheses may not be cost-effective. Long-term experience may have to be substituted for short-term confirmed prognosis (See 3.2.4, 3.2.5, 3.2.7, 3.3.5.2).

7.5.10 BUSINESS DEVELOPMENT OFFICERS

Business Development Officers should continue to be trained and encouraged to teach clients the use of the calculator and other materials supplied by the Numeracy Project (See 3.2.4, 3.2.7).

7.5.11 OTHER GOVERNMENT OFFICERS

1 Many Government officers need to be taught how to use the calculator properly (See 3.5.2).

2 Until they have been taught themselves they cannot pass on the skills to others.

3 For this reason calculator-skill training should be given to Government officers (and staff of voluntary agencies) as part of the adult numeracy programme (See 3.[illegible]).

7.5.12 OTHER AGENCIES

Full co-operation with the Departments of Commerce, Education and the Community and Family Services has already been established. The Department of Primary Industry is investigating possibilities. Co-operation with other Departments, Provincial Governments and with voluntary agencies need to be further developed (See 3.5.10).

7.5.13 REACHING THE VILLAGERS

1 The attempt to teach villagers by giving an intensive course to representatives failed because the representatives did not pass on what they had been taught (See 3.3.1).

2 Visiting villages for an hour or two and giving a lesson to those adults who were available appeared to produce good results but no systematic follow-up of this attempt was carried out (See 3.3.1).

3 Prior organisation for such visits however was essential and when this broke down the visit could be wasted (See 3.3.1, 3.3.2).

4 Visits specifically to train village people would only be practicable if staff were specially appointed to carry out such a programme.

5 Appointing staff specially to carry out a nationwide programme of direct teaching would be very costly.

6 The practicable alternative would seem to be to work through existing agencies and their extension officers (See 6.3.4, 7.6.7).

7.5.14 CALCULATORS IN SCHOOLS

The Papua New Guinea culture is certainly (at best) partially numerate and the principle of 7.3.5 applies: calculators should be introduced into Primary Schools as early as possible (See 3.5.5).

7.6 SUGGESTIONS FOR FURTHER RESEARCH

7.6.1 THE CALCULATOR AS AN EDUCATIONAL AID (See 6.7.3, 6.7.4, 6.7.8, 6.7.9, 6.7.10, 6.7.11, 6.7.12)

The use of the calculator at all levels in:

1 Concept development

2 Learning of number facts

3 Applications to specific situations likely to be met in real life

7.6.2 FRACTIONS

The extent to which the teaching of fractions can be safely reduced, particularly in a metric society.

eg: in Primary education, only the use of ½'s and ¼'s?

in Secondary education for the "majority", only ½'s, ¼'s, $\frac{1}{3}$'s, $\frac{1}{5}$'s, $\frac{1}{10}$'s, $\frac{1}{100}$'s, the use of fractions to denote division, and "cancelling down"?

(See 5.15, 6.5.3, 6.7.6(10), 6.7.11(20))

7.6.3 RATIO AND PROPORTION

The various methods which may be used to teach the solution of problems on ratio and proportion with the calculator (See 5.15).

7.6.4 APPROXIMATION AND ESTIMATION

The various methods of approximation and estimation that are appropriate in real life situations (See 5.8, 5.15,6.2.(3). 6.6.6, 6.7.6(12)).

7.6.5 OPTIONAL MATHEMATICS FOR THE MINORITY

The provision of optional mathematics courses for those who wish to take the study of mathematics beyond that which is appropriate for the "majority" (See 6.1, 6.2, 6.3.2, 6.7.7).

7.6.6 ADULT NUMERACY

Any practical adult numeracy work using the hand-held LCD calculator will provide an opportunity for further research in this new and potentially vast field (See Chapter 3, 5, 6.3.4, 6.6, 6.7.6(6)).

7.6.7 REACHING VILLAGES IN PNG

The major research that must now be carried out in Papua New Guinea is to discover whether an Adult Numeracy Programme can be effectively carried out through existing agencies and their extension officers (See 7.5.12).

7.6.8 PROBLEM-SOLVING TECHNIQUES

To what extent will the currently popular analysis of problem-solving techniques actually assist the "majority" in the real world? (See 6.2, 6.5.5, 6.7.6(18), 6.7.11(21)).

7.6.9 MICROCOMPUTERS

In all research with the calculator it should be remembered that it may before very long be replaced by a cheap hand-held microcomputer. This may not yet be a realistic subject for specific research but the escalation of development in this field requires that the probability should be borne in mind (See 6.7.8).

NOTE on Appendices

148 References are provided in the thesis.

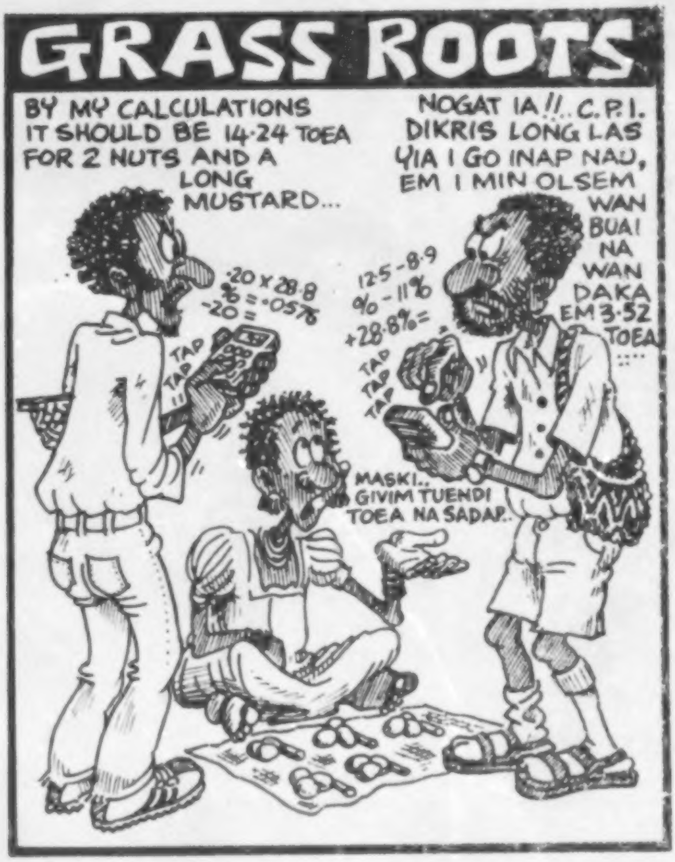
Appendix 1 of the thesis consists of an Information Pack produced in January 1982.

Appendix 2 consists of the "Adult Numeracy Reports" ANR 1 - ANR 18, on the 18 Tours undertaken by the author and his wife in 1980-81.

Appendix 3 consists of samples of materials produced by the Numeracy Project, from which a selection is included herein.

NUMERACY PROJECT

DEPARTMENT OF COMMERCE
PAPUA NEW GUINEA


GRASS ROOTS
BY MY CALCULATIONS IT SHOULD BE 14·24 TOEA FOR 2 NUTS AND A LONG MUSTARD...
·20 X 28·8 % = ·0576 -20 =
TAP TAP
NOGAT IA!!.. C.P.I. DIKRIS LONG LAS YIA I GO INAP NAU, EM I MIN OLSEM WAN BUAI NA WAN DAKA EM 3·52 TOEA....
12·5 - 8·9 % - 11% +28·8% =
TAP TAP TAP
MASKI.. GIVIM TUENDI TOEA NA SADAP..

Project Development Staff: Mary Dickie
Allen Edwards
Mary Edwards

Acknowledgement

The Cartoon is reproduced by permission of The Grass Roots Comic Company, Port Moresby.

A rough translation of the Pidgin is:
No! The Consumer Price Index decrease from last year until now means that one betelnut and one mustard is 3.52 toea.

Forget it ..... Give me 20 toea and shut up.

THE NUMERACY PROJECT

SHARP
12345678.

For the majority of Papua New Guineans who live in rural areas (some 85% of the population) and who still follow a more or less traditional way of life, the 700 different languages and 250 counting systems present no real problem - as long as they stay in their own village. As soon as they step beyond its boundaries, they need to be able to communicate with others and to deal with the changing social and economic environment. Most people in accessible areas do learn and use one of the official languages (English, Pidgin or Motu) but few have yet come to grips with international counting and measuring systems to enable them to deal with money and numbers as they need.

In the village setting, the requirement for using "western" numbers might seem very basic - as simple as putting a price on the scones baked in a drum oven; but if you cannot add together the price of ingredients and fuel and divide by the number of scones made, you could easily sell them at a loss. And many people do. If you have a small commercial, industrial or agricultural project, you need greater number skills than that - for working out materials estimates, overheads, prices, stocktaking, bank accounts etc. And yet the kind of basic arithmetic involved is often beyond the skills of a university student, so for those who have had little or no formal education, these problems seem almost insurmountable. However, 1980 saw the introduction of the liquid crystal display calculator - a remarkably cheap hand-held calculator, with an estimated battery life of some 10,000 hours. This new technology provided a tool which could be used in a village for a very long time, provided that people could learn how to use it to solve their number problems.

So during the last 18 months, the Department of Commerce has been trying to find out what sorts of problems people encounter with numbers in their daily lives and to discover a means of teaching people to tackle these for themselves, without the help of an extension officer, by using a calculator. The range of problems we uncovered was very wide - a man who could not re-roof the community hall because he could not work out how many sheets of iron he should buy; a woman who made tapioc parcels to sell at the market and ended up with less money than she started with, after she had sold them all; many tradestore keepers who could not give the right change from a kina; farmers who could not work out how many posts and how much wire to buy to fence their coffee blocks. The examples are endless. Collecting all of this information together only served to emphasise the extent of the problem we were trying to deal with.

Following this, we have been experimenting with a whole variety of training methods and materials, with village and business groups and government extension workers in 5 Provinces. We have tried to teach people the basic and essential number skills they need for their own practical purposes, basing all our efforts on the use of a hand-held calculator as the means of learning and the means of solution.

During all this time, the project has focussed certain key facts:

- people in Papua New Guinea have very readily adapted to using new technologies in many spheres of everyday life, so learning the Arithmetic they need with the help of a calculator could be appropriate, provided that the calculator itself would not run down.

- to be successful, basic skills training has to be directly related to practical tasks, and teaching has to be aimed at the problems which each individual or group has to deal with.

  e.g. understanding and using a calendar to calculate gestation periods for pigs or cattle

  e.g. adding costs and dividing by quantities produced, for a women's group making clothes or bread

- new skills can be learned for new needs, without destroying or changing traditional ways.

  e.g. just as many people learn pidgin or english, but do not "forget" how to speak ples tok, so could they learn western arithmetic without abandoning their traditional counting systems for village uses.

- developing new concepts is the most difficult problem in education, but learning a routine to deal with a specific task is not; so our training should be aimed at teaching people precisely what to do, when and how, which numbers to use to solve a problem, rather than attempting to achieve an overall understanding of arithmetic.

Further details of the project's activities and results of the experimental period are described in the attached collection of papers.

The project is now aiming to extend its work outside the "business only" boundaries which it has previously emphasised. Preliminary discussions with 3 major extension departments - Education , Primary Industry and Community and Family Affairs - have been very encouraging and we hope to be working very closely with them in 1982, and to produce materials appropriate to their areas of interest.

Any further information about the project which may be required can be obtained from the Project Director, Allen Edwards, at Laloki College, PO Box 1864, BOROKO.

October 1981

Mary Dickie
Assistant Secretary, Training & Staff
Development, Department of Commerce.

AN 38

Papua New Guinea

DEPARTMENT OF COMMERCE
(BUSINESS DEVELOPMENT)

TELEGRAMS: BISDEV
TELEPHONE: 27-6111

CENTRAL GOVERNMENT OFFICES.
P.O. BOX WARDS STRIP.
WAIGANI.
PAPUA NEW GUINEA.

Date:
Our Reference:
Action Officer: A. Edwards
Designation: Director, Numeracy Project

Your Reference:
Date: 12. 2. 82

ADULT NUMERACY

The invention of the cheap calculator with long-lasting battery has created a new possibility of universal adult numeracy.

Papua New Guinea has an eighteen month headstart over any other country on such a programme. In March, 1980 the Department of Commerce set up a Numeracy Project which received support from the Prime Minister's Department Non-formal Education Sectoral Fund. Some of the resulting teaching materials are in the enclosed Information Pack.

Business Development Officers are being trained to use the materials. Other Departments and agencies are working out, in consultation with the Project, how to adapt or use the materials and training that are available.

The Southern Highlands Provincial Literacy Committee for example, is concerned with people who cannot read or write or use "Western" numbers. A special course has been written for them to use alongside their literacy teaching.

The Mathematics Syllabus Advisory Committees for both Community and High Schools have asked for research to be carried out in 1982 into the feasibility of teaching calculator skills to those who will leave school from Grades 6, 8 and 10.

The Community and Family Services Department has asked for advice on materials and training for youth leaders and women's workers. They are already telling their officers how to obtain materials and suggesting they approach their Provincial Business Development Officers to assist with the training.

Non-formal Education has requested a comprehensive programme to use with their own trainees in Vocational Centres and in extension work with villagers engaged in income-generating projects.

An overseas volunteer agency has begun to brief its workers on their arrival in the country, so that they can spread knowledge of the materials and training available.

Experience has shown that business people and others are keen to learn, but they do need to be taught. The Business Arithmetic Workbook is intended as a manual for the teacher as well as an exercise book for the learner. Very few villagers could learn direct from the Workbook: they would find it hard even to use the Book to remind them of what they have learnt. A series of cartoon posters has therefore been planned with minimal writing, in Pidgin, to remind them of the procedures they have learnt.

A Calculator-skills Pack is also proposed, to include the material in Units 1 and 2 of the Workbook together with work on the Cash Book and Measurement applications. This would probably consist of a detailed teacher's guide in English together with exercise sheets in Pidgin.

The first priority of the Numeracy Project now will be to discuss the possible programmes with Government Departments and other agencies who have the capacity to carry the teaching to the people. It will also be concerned, through the media, to stimulate the demand for numeracy. Cost-effectiveness comes from matching provision to demand.

There is no one in the world who can tell us how to programme adult numeracy. There will be plenty of other countries eager to learn from Papua New Guinea's experience.

Could the people with whom you are concerned become more self-reliant if they had better number-skills? If so, and if you think we could help in any way will you please contact us? Then we can discuss how the materials could be adapted and the training provided.

If you are interested please write or telephone to:

The Director,
Numeracy Project,
Laloki College,
PO Box 1864
BOROKO.

Telephone: 281060/281064.

JOHN WAUWE,
SECRETARY.

DEPARTMENT OF COMMERCE NUMERACY PROJECT

LIST OF ITEMS AVAILABLE: 17.7.81

Note: items on the previous list dated 1.4.81 and now omitted, could still be reproduced if required.

Reference	BASIC NUMERACY
BN 1	First Draft of Course submitted to Southern Highlands Literacy Committee. (see ANR 10). Part 1: Without calculators. Lessons 1-22: counting up to 20 objects, using the figures for adding two numbers totalling up to 20; subtracting 1, 2, 3 from numbers up to 20. (written May 1981). Part 2: using number games on the calculator to learn number bonds as above, subtracting from 10 and change from a kina. (written late June 1981). (Part 3 is likely to follow the lines of AND (see below))
BNE 1	Exercises and Tests for BN 1.
	ADULT NUMERACY: DAY-BY-DAY
	First draft in Pidgin, of course designed to be used in villages in a series of 1-hour lessons. Each day's exercises are on one side of A4 with Practice exercises on the back to be done between visits, each also revising the earlier work. (Written June 1981, see ANR 12).
AND 1	Totalling and finding change including multiple purchases (not mixing x and +); Cash Book balances and checking by totalling IN and OUT. Ⓒ used at first but (CE) introduced at the end.
AND 2	Mixing x and + with purchases using memory where necessary; notes & coins slips, invoice checking.
AN 12	

AND 3	Each x number = total; Total ÷ number = each; Total ÷ each = number, applied to money; Pricing cargo; measuring in m/cm; comparing and +, −, x, ÷ with lengths.
AND 1A/B/C	Three very similar tests on AND 1.
AND 2A/B/C	Three very similar tests on AND 2 and AND 1.
AND 3A/B/C	Three very similar tests on AND 3,AND 2, AND 1.
AND 1/2/3/A/B/C/T	Answer sheets for the above.
	BUSINESS ARITHMETIC
BAW	First draft, in Pidgin, of Workbook designed for teaching individual clients, particularly Trade Store keepers. (written mid-May 1981).
BAW 1	Unit 1: Totalling & giving change (+ & - only)
BAW 2	Unit 2: Invoice Checking.
BAW 3	Unit 3: Pricing Cargo (no freight)
BAW 4	Unit 4: Pricing Cargo (with freight)
BAW 5	Unit 5: Cash Book
BAW 6	Unit 6: Leakage Check
BAM 1	Memorandum, summarising the work (written June 1981, see ANR 11).
BAWE	First English Draft of workbook, revising the materials used in BAW above. (written early July 1981, to be illustrated and printed August 1981).
BAWE 1	Unit 1: Totalling and giving change. Multiple Purchases. Mixing ⓧ and ⊕: use of memory. All answers checked by working backwards. Use of (RCM) twice for clearing memory.

BAWE 2	Unit 2: Invoice Checking and Pricing Cargo without freight.
BAWE 3	Unit 3: Pricing Cargo with freight: Part A dividing Total freight by number of cartons, Part B using freight as a % of cost, Part C multiplying weights by freight per kg (including decimal of a kg).
BAWE 4	Unit 4: Cash Book and Bank Book: checking the balance by totalling IN and OUT; Cheque Account and Bank Reconciliation.
BAWE 5	Unit 5: Leakage Check and Net Liquid Assets: Stocktaking with and without cartons in storeroom; finding value of all stock sold in period. Estimating value of stock at cost adding cash and subtracting unpaid bills to find net liquid asset as a means of assessing the business.
BAME	Memorandum sheets for BAWE (not yet written).
	MISCELLANEOUS EXERCISES
Cross-totalling on an Analysis Sheet. 3 ANCS 1.4	Using the memory to total the totals of columns to check the grand total on an analysis sheet.
Revision Sheet: Finding Change 3 ANCS 1.5	Finding the change from K2, K5, ... K30 for 2, 3, 4 items.
Cross-Totalling on a table. 3 ANCS 1.6	Four rows and six columns of money are totalled and the grand total checked using the memory.

Checking an Invoice 3 ANCS 1.7	Full instructions including correction of errors and two examples using the memory.
Notes and Coins Slips 3 ANCS 1.8	Examples of completed Notes and Coins slips, to be totalled using the memory. (For blank forms see 6.2)
Number Games 3 ANCS 2.1	The way to use the calculator to practise +1, +2, -1, 10-, 100- etc are set out.
Simple totals and change without the calculator. 3 ANCS 2.2	Totalling 2 or 3 multiples of 10t and giving change from K2.00 without the calculator.
Harder totals and change, without the calculator 3 ANCS 2.3	Change from K1.00 or K2.00 for any number of toea and totalling two numbers of toea without the calculator.
Test on Addition (1) 3 ANCS 2.5	57 questions testing +1, +2, and number bonds for 10 and 11.
Test on Addition (2) 3 ANCS 2.7	57 questions testing addition of all pairs of single digit numbers.
Weighing coffee/ cocoa 3 ANCS 3.3	It is intended that actual scales be used to demonstrate correct principles of weighing. The exercise enables the prices of bags to be totalled using the memory.
Timber Requirements 3 ANCS 3.4	Listing requirements for each size of wood, totalling the length with the memory and costing it.
The Clock 3 ANCS 3.5	This is a 6-page Self-paced unit teaching the time (o'clock, quarter past, 20 to etc.) and what it will be in 1, 2, 3, ½ and 1½ hours.

Test on the Clock 3 ANCS 3.6	Single sheet testing 3.5
Calendar 3 ANCS 3.7	A calendar is provided, dates asked in so-many days, weeks, fortnights and months. Days on given dates. USE BY dating. Numbers of days, weeks, fortnights between given dates. Numbers of Sundays in a month. Ages on given dates. Counting on the fingers encouraged. (Pidgin version written in April 1981)
Lengths & Money 3 ANCS 3.8	Measuring, comparing, totalling, differencing lengths of 4 sticks, 4 strings etc. Comparing, totalling, differencing 3 piles of money (written late April 1981, see ANR 10)
Finding Selling Prices 3 ANCS 4.3	Finding SP given markup %, with and without freight (dividing total freight by number of cartons).
Finding Markup % 3 ANCS 4.4	Finding markup % when the Selling Price is known (with freight only).
Stock Taking 3 ANCS 4.6	Instructions are given for counting (by 1 ⊕ ⊜ ⊜ ⊜) and for counting by piles and cartons. The Value-if-all-sold is found using the memory.
Bank Book Test 3 ANCS 4.9	This is a Mastery Test (AB223A) on use of Cheque Account and Reconciliation.
Stock Control 3 ANCS 4.11	Stock is divided into Fast, Medium and Slow moving. Average sales per period is found. Rules for time and amount to reorder are suggested (written late June 1981)
Length 3 ANCS 5.1	Working in m/cm it reviews, with a calculator, the work in 3.8 and includes price per metre, the use of this to find cost of a given length of material, the length left over after making a number of garments from a given length, lengths and widths of numbers of plywood/fibro sheets and number required; similarly for corrugated iron.

Pricing Kaikai 3 ANCS 5.2	Costs are calculated by the "batch" using multiplying, halving, quartering, estimating and dividing. 80% is added for unpaid labour, profit etc.
Pricing Sewing 3 ANCS 5.3	Cost per metre is found and used to cost material for a garment etc. Costs of "extras" and "making" include labour and profit.
Local Distances and PMV charges 3 ANCS 5.4	Charge per km is found in toea to 1 decimal place. 'Longer', 'shorter' and 'half-way' are identified. Proportion is used to estimate other charges.
Estimating Lengths 3 ANCS 5.5	Lengths are to be estimated in m/cm and judged on whether they are between half and twice the true length.
Comparing Prices 3 ANCS 5.6	Four pages include comparing costs by costing the bigger one at the price per gram of the smaller one, and finding the "savings".
ⓧ and ⨸ 3 ANCS 5.7	Three exercises involving miscellaneous ⓧ and ⨸ problems.
The Constant Function. 3 ANCS 5.8	A single sheet summarises the use of the constant function for Number Games, Converting units (miles to km) and changing the maximum for a set of marks. (Intended for School Teachers.)
Calculation in Trade Stores 3 ANCS 5.9	A single sheet summarising the principles required by Trade Store keepers for correcting mistakes, totalling & finding change, checking invoices, finding selling prices and profit, stocktaking, net worth and leakage. (The last parts are now superseded.)
Wage Calculations 3 ANCS 5.10	Checking and correcting a Wage Sheet with deductions for tax and rent. (written late April 1981, see ANR 10)

Church Health Services Form 3 ANCS 5.11	Adding, subtracting and transferring figures according to instructions on the form (written late April 1981, see ANR 10)
Pricing Artifacts and Services 3 ANCS 5.12	Finding how long from one time to another (to a quarter of an hour) multiplying by rate per hour and adding other costs (written May 1981)
Miscellaneous Costs 3 ANCS 5.13	Calculations involving costs of eggs, calculators, printing, second-hand clothing, travel, lumber, air freight and rice by the cupful. Conversion from stock valued at SP to valuation at CP. (written May 1981)
Cattle Project 3 ANCS 5.14	Calculating area, perimeter, numbers of posts, lengths of wire, weights of staples, numbers of head of cattle, sale of steers. Test on the same. (written May 1981).
Constant Function Problems 3 ANCS 5.15	Conversion yds/m, kg/lb, K/$A and in reverse by division. Adjusting school marks proportionally (written May 1981).
Plantation Areas 3 ANCS 5.16	Numbers of trees per hectare. (written May 1981).
Miscellaneous Problems 3 ANCS 5.17	Numbers of truck loads needed, finding the page (or hymn number), giving a customer change. (written May 1981).
Cardamom Project 3 ANCS 5.18	Area of rectangle and conversion ha/m^2, numbers of plants in a field, yield, number of workers needed, selling the crop, (written June 1981, see ANR 12)
Standard Nursing Problems 3 ANCS 5.19	Calculating amount to draw up a syringe, numbers that can be vaccinated with one viol, proportion of IV fluid run in, drops per min. Use of (%) and (M+) keys.

BLANK FORMS

Certificate 3 ANCS 6.1	Certificates for issue on completion of Adult Numeracy or Business courses.
Notes & Coins 3 ANCS 6.2	Blank forms: see 1.8, printed both sides.
Cash Sheet 3 ANCS 6.3	Blank forms: Two IN columns, 1 OUT and balance. Instructions are on the back.
Stock Taking 3 ANCS 6.4	Blank forms.
Bank Book Sheet 3 ANCS 6.7	Blank forms including space for Bank Reconciliations. Instructions are on the back.
Analysis Sheet 3 ANCS 6.8	Income for a Trade Store is analysed into 6 columns, expenditure into 11. Instructions are on the back.
Fixed Asset Valuation Sheet 3 ANCS 6.9	As appropriate for a Trade Store. Instructions are on the back.
Trading Statement 3 ANCS 6.10	Instructions on the back assume the use of 6.3, 6.4, 6.7, 6.8, 6.9.
Balance Sheet 3 ANCS 6.11	Instructions on the back assume the use of 6.10.
Stock Control Card 3 ANCS 6.12	Blank form for one item: see 4.11

AN 12

APPARATUS & CARDS

Calculators	Sharp EL220 are sold on behalf of the Laloki College Canteen currently at the following prices: By post - K6.00; by collection from Laloki - K5.50; for specified Adult Numeracy work - K5.00; by special agreement to those undertaking to sell them at not more than K7.00 each as part of a follow-up operation, K55.00 for 10, carriage paid. (Scientific (EL508) calculators are also sold at K13.00 each)
Metre Rulers	In 50mm x 12mm plywood, marked in cm, labelled .01, .02, ..., .99 and polyurethaned. Not generally for sale. Price on Adult Numeracy Courses 40t.
Sum-Ten	A game on a square card (256mm x 256mm) using counters marked 1, 2, 3, 4, 5, 6 and 7, drawn on a similar square card ready for cutting out. Object is to get four counters in line totalling 10. 20t.
Snap Cards	There are four versions having cards showing sums or differences of single digit numbers, (a) from 0 to 5, (b) from 6 to 10, (c) from 11 to 15, (d) from 16 to 19. Supplied as sets of 8, 10, 10 or 8 half squares, each to be cut into 5 cards. 30t
Small Numerals	Sets of numerals 0 to 20 on 63mm square cards, supplied as 3 half squares. 20t
Big Numerals	Sets of numerals 0 to 10 on 193mm x 128mm cards.
Adding up to 20	Sets of number cards 2cm to 20cm long provide self-checking practice in adding numbers up to 20.
Car Race Game	Single sheet for game on track with spaces numbered 1-100 10t

REPORTS

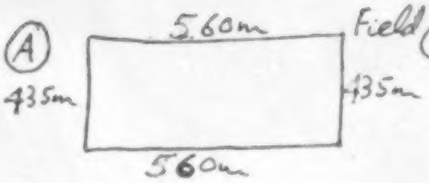
Note all other reports can be copied if required: the following are readily available.

ASA	Arithmetical Skills of Adults in Papua New Guinea: A Subjective Enquiry (September 1980)
AN 2	Teaching Games with the Calculator (use of the constant function only).
AN 5 (part)	Note on Measurement: extract from Report on Popondetta visit (October 1980).
ANR 3	Report on Visit to Southern Highlands, 29 October - 8 November 1980.
ANR 4A	Report on the First Village Representatives Adult Numeracy Course, Wewak: Nov 27 - Dec 2, 1980 (in short supply).
ANNL 1	Adult Numeracy in Papua New Guinea: Newsletter No.1 of the Department of Commerce Numeracy Project, January 1981.
ANR 10	Report on Second Visit to the Southern Highlands, 7-24 April 1981.
ANR 11	Visit of Bryan Wilson, Mathematics Consultant of the British Council, Visits to Lae and Popondetta, 4 to 16 May 1981.
ANR 12	Visit to Morobe Province, 1-12 June 1981, also followup on Goroka and Nipa courses, etc.
ANNL 2	Adult Numeracy in Papua New Guinea: Newsletter No.2 of the Department of Commerce Numeracy Project, May 1981.
AN 12	List of Units Available, 17.7.81. (This list)

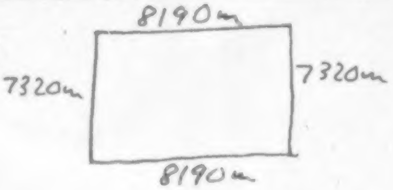
CATTLE PROJECT

ise 1

ield Ⓐ


5.60m
435m
435m
560m

Field Ⓑ

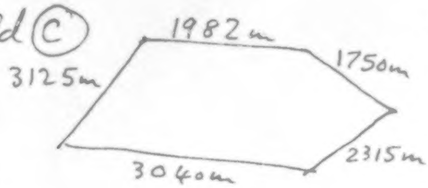

8190m
7320m
7320m
8190m

If your block of land is this shape ("rectangle") you can find its area in hectares by:
length ⊗ breadth ⨸ 10 000 ⊜ → area in hectares.

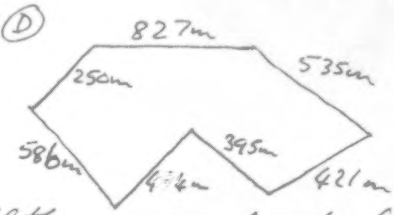
So area of Field Ⓐ is: . . . . . . hectares
area of Field Ⓑ is hectares.

To find areas of other shaped fields you will need a proper survey map.

Field Ⓒ


1982m
1750m
3125m
2315m
3040m

Field Ⓓ


827m
535m
250m
395m
586m
421m

The "Perimeter" is the distance all the way round a field: to find the Perimeter you add all the sides together.

Perimeter of Field A = ... m
Perimeter of Field B = ... m
Perimeter of Field C = ... m
Perimeter of Field D = ... m

Small posts (or iron "pickets") are needed every 4m, so you can find the number needed by dividing the perimeter by 4. But you should get some spare ones, so add 5% for this. So the rule will be:

Perimeter ⨸ 4 ⊕ 5 (%).

Number of small posts needed for Field Ⓐ . . . .
" . . . . Field Ⓑ . . . .
" . . . . Field Ⓒ . . . .
" . . . . Field Ⓓ . . . .

PTO

7. Big "strainer" posts are needed every 100 m and also at every corner. You will have to count the number of corners by looking at the pictures on page 1.

To find the number of big posts use:

Perimeter ⨸ 100 ⊕ number of corners ⊜

("Round up", to the number 1 more than you get by forgetting everything after the decimal point.)

Number of big posts needed for Field Ⓐ ......
" " " Field Ⓑ ......
" " " Field Ⓒ ......
" " " Field Ⓓ ......

If you need 4 strands of wire for the fence you must multiply the perimeter by 4 to find the length of wire needed. If the wire comes in 400m rolls you must then divide by 400 to find the number of rolls needed. Add 5% for safety and "round up" as in question 4. So you will use:

Perimeter ⊗ 4 ⨸ 400 ⊕ 5 (%) ⊜ and round up.

Number of rolls of wire needed for Field Ⓐ ....
for Field Ⓑ .... for Field Ⓒ .... for Field Ⓓ ......

If you have 4 strands of wire you will need 4 staples for each post, and add 5% for safety. So use:

Number of small posts ⊕ number of big posts ⊕ 5 (%).

Number of staples needed for Field Ⓐ ......
for Field Ⓑ .... for Field Ⓒ .... for Field Ⓓ ......

Staples are sold in boxes of 50kg. or 25kg. To find the weight of staples needed you must divide the number you want by the number you get in 1kg. (To find this you can weigh out 1kg and count them.) To find the number of boxes you need you must divide this weight by the weight in 1 box. So use: Number of staples needed ⨸ Number of staples in 1kg ⨸ number of kg. in 1 box ⊜ Then "round up". If they are 25kg boxes and you get 500 staples for 1kg find the number of boxes for Field Ⓐ ......
Field Ⓑ ...... Field Ⓒ ...... Field Ⓓ ......

cont.

ANCS 5.14 (2)

The number of head of stock you can carry depends on he quality of the grass. Suppose you can have 3 cattle per hectare, then use: area ⊗ 3 ⊜.

Number of cattle you can have in field Ⓐ ......
in Field Ⓑ ..... in Field Ⓒ ...... in Field Ⓓ ....

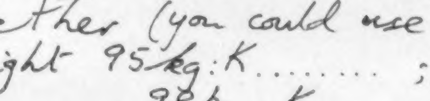
You will have to reduce your stock before the dry season begins. it is now February, how many months is it till June? ...... (Don't count February)
If it is now May, how many months is it till December? .....
If it is now November how many months is it till May? ......

Suppose the butcher will give you K1.25 per kg dressed weight. How much money will you get for each of the following steers and how much will you get altogether (you could use the memory for this)
Dressed weight 95 kg: K .... ; 137 kg: K .... ;
243 kg: K ..... ; 98 kg: K ...... ; 112 kg: K ....
Total cash for all 5 steers: K ......
Check this by working out Total dressed weight ...... kg
How much for this weight at K1.25 per kg: K ....

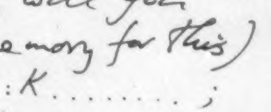
ercise 2

This will test whether you understood Exercise 1. These questions are all like those you had in Exercise 1 but the numbers are different. Look back at the question in Exercise 1 with the same question number to find how it was done there.

Field Ⓔ



Field Ⓕ



rea of Field Ⓔ: ...... hectares.
Perimeter of Field Ⓔ ...... of Field Ⓕ ....

3. How many small posts if they are placed 3 m apart and you add 10% for safety:
Field Ⓔ: .... Field Ⓕ ....

4. How many strainer posts placed every 80m and at every corner for Field Ⓔ ...... , Field Ⓕ ......

5. You are going to put 3 strands of wire. The wire comes in 400 m rolls. How many rolls will you need if you add 5% for safety: Field Ⓔ .... Ⓕ ......
(Round up).

If you have 3 strands of wire and add 5% for safety how many staples will you need: Field Ⓔ .... Ⓕ ....

7. Suppose you get 400 staples per kg and a box contains 50 kg. How many boxes for Ⓔ ...... Ⓕ ......

If you can carry 4 head of stock per hectare, how many cattle can you have in Field Ⓔ ..... Ⓕ ......

If the dry season begins in May and it is now December, how many months have you in which to reduce your stock? ......

If you get K1.10 per kg dressed weight what will you get for each of these steers, and the total:
Dressed weight 113kg: K...... 290kg: K.... 154kg: K..
88 kg: K...... Total cash for all 4 steers K......
Check: Total weight of 4 steers: ..... kg.
Total cash for this total weight: K......

END

CONSTANT FUNCTION PROBLEMS

you want to multiply a lot of numbers by the same number you can "set" the calculator (as in Number Games) by pressing: the number ⊗ the number ⊜.
Then when you press any other number and ⊜ you will get this number x the number the calculator is set for.

To convert yards into metres you must multiply by 0.914.
So set the calculator by: 0.914 ⊗ 0.914 ⊜
(do not forget the decimal point).
Fill in the "metre equivalents" for the following, writing them with 2 figures after the decimal point.

2 yards = ... m. 3 yards = ... m. 10 yards = ... m
17 yards = ... m. 24 yards = ... m. 100 yards = ... m
220 yards = ... m. 440 yards = ... m. 500 yards = ... m
1760 yards = ... m. $1\frac{1}{2}$ yards (1.5) = ... m. $4\frac{1}{2}$ yards = ... m
$3\frac{1}{4}$ yards (3.25) = ... m. $2\frac{1}{4}$ yards = ... m. $1\frac{3}{4}$ yards = ... m
(1.75)

1 lb = 0.454 kg so to change pounds into kg you must multiply by 0.454. Set your calculator for multiplying by 0.454.
Fill in the "kg equivalents" for the following, writing them with 2 figures after the decimal point.

3 lb = ... kg. 14 lb = ... kg. 28 lb = ... kg
2 lb = ... kg. 2240 lb = ... kg. $2\frac{1}{4}$ lb = ... kg
lb = ... kg. $9\frac{1}{2}$ lb = ... kg. $4\frac{3}{4}$ lb = ... kg

1.00 = $A1.2905, set your calculator to multiply by 1.2905.
ork these in kina, i.e. use the decimal point and write the swer with 2 figures after the decimal point. When you are working in Kina you can miss out .00 in K5.00 etc.

ANCS 5.15 (1)

P.T.O.

3(Cont.)

K 3.00 = $A .... K10.00 = $A .... K9.50 = $A ....
K13.75 = $A .... K 184.50 = $A ..... K47.03 = $A .....
K500.00 = $A .... K2000.00 = $A .... K6000.00 = $A ....

With whole numbers of kina you use the numbers as they are, and give answers to these big numbers in the same way, forgetting anything after the decimal point. Example: K7588 = $A9792.

K4360 = $A ...... K21,000 = $A ...... K1,500,000 = $A ....

You can set the calculator to divide by a number similarly by pressing: the number (÷) the number (=).

To convert metres back into yards you divide by 0·914.

Set your calculator and do these: (include decimal points)

5 m = ... yards 100 m = ... yards
17·31 m = ... yards 500 m = ... yards.

To convert kg back into lb you divide by 0·454.

Set your calculator and do these:

3 kg = ... lb 10 kg = ... lb. 17 kg = ... lb.
4·23 kg = ... lb. 913·4 kg = ... lb 1.38 kg = ... lb

To convert $A back into Kina, divide by 1.2905 (or whatever)

$A5.00 = K ...... $A6.53 = K ...... $A14.64 = K ....
$A71.34 = K ..... $A 310.00 = K ......

Give these in whole numbers of K as in question 3:

$A 7000. = K ..... $A124,000 = K ....

If school marks are out of 40 and you want them out of 85, work out 5 (÷) 40 (=). Then multiply by what you get. Set your alculator and change these marks out of 40 into marks out of 85:

39 out of 40 → ..... out of 85; 21 → ..... out of 85; 7 → ......; 19 → ....
40 → ......; 23 → ......; 5 → .....

Use the same method to change these marks out of 80 into marks out of 50 (work out 50 (÷) 80 (=)) and set your calculator.

32 out of 80 → ..... out of 50; 65 → ......; 24 → ......;

ANCS 5.15 (2) 46 → ...... 80 → ......

END

Department of Commerce Numeracy Project

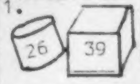
[redacted]ST [redacted]UL[redacted] CO[redacted]: [redacted] [redacted]NIT[redacted]

Ⓒ means the CLEAR key

It switches the calculator on and you can use it if you make a mistake. Press Ⓒ you see 0? Press 1: you see 1? Press 2 you see 12? Press 3: you see 123? Press Ⓒ 123456789. It does not show 9: the calculator was full up. Look carefully at 4,5,6. Press Ⓒ

Exercise 1. Totalling in a Trade Store

1.



....

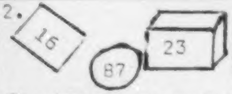
write answer

+ is called PLUS

= is called EQUALS

Press 26 ⊕ 39 ⊜ When you have finished you do not need to press Ⓒ

2.

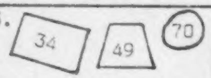


....

write answer as K1.26.

Check your answer with 23 ⊕ 87 ⊕ 16 ⊜

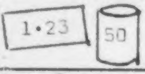
3.



....

Check with 70 ⊕ 49 ⊕ 34 ⊜

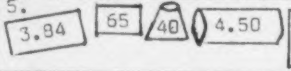
4. DO NOT press the point key



....

Check with 50 ⊕ 123 ⊜

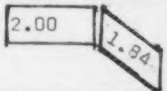
5.



....

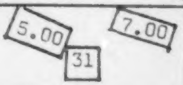
Check as usual

6. For K2.00 you must press 200



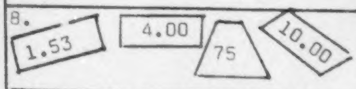
....

7. For 5.00 and 7.00 press 00 as you say KI-NA



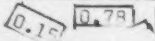
....

8.



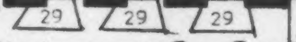
....

9. Press you see onl you do



Exercise 2. Multiple Purchases

1. [redacted]



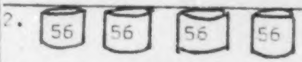
....

× is called TIMES

First press 29 ⊕ 29 ⊕ 29 ⊜

Then press 29 ⊗ 3. Same answer ?

2.

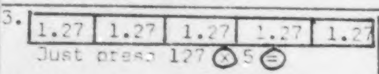


....

First press 56 ⊕ 56 ⊕ 56 ⊕ 56 ⊜

Then press 56 ⊗ 4 ⊜

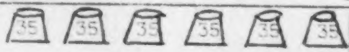
3.



Just press 127 ⊗ 5 ⊜

....

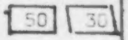
4.



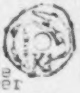
....

Exercise 3 Finding Change.

1.



Total .....



Change ....

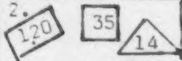
− is called MINUS

Press 50 ⊕ 30 ⊜ write answer

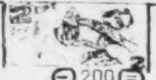
Press ⊖ 100 ⊜ write answer

Check the change by pressing 50 ⊕ 30 ⊖ 100 ⊜

2.



Total ....

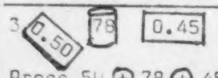


Change ....

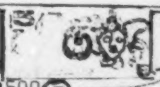
Press 120 ⊕ 35 ⊕ 14 ⊜ ⊖ 200 ⊜

Check: 120 ⊕ 35 ⊕ 14 ⊖ 200 ⊜

3



Total ......

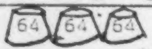


Change ......

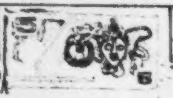
Press 50 ⊕ 78 ⊕ 45 ⊜ ⊖ 500 ⊜

Check: 50 ⊕ 78 ⊕ 45 ⊖ 500 ⊜

4.



Total .....

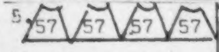


Change ......

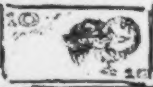
64 ⊗ 3 ⊜ ⊖ 500 ⊜

Check: 64 ⊗ 3 ⊖ 500 ⊜

5.



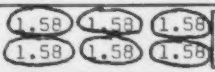
Total .....



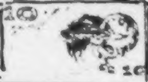
Change ......

Check as usual

6.



Total .....



Change ......

Exercise 4 Cash Book

[redacted]

Start:1395 ⊕ 5400 ⊜ and enter new balance

Continue: ⊖ 1200 ⊜ and enter new balance

If you make a mistake press Ⓒ and start again with last correct balance.

Date		In ⊕	Out ⊖	Balance ⊜
2.7.81.	Brt fwd	————	————>	13.95
2.7.81	Sales	54.60		.....
3.7.81.	Work boy		12.00	.....
4.7.81.	Cargo		48.26	.....
4.7.81.	Freight		6.50	.....
4.7.81.	Sales	57.91		.....
	TOTALS	......	......	....

Check: First Balance ⊕ Total In ⊖ Out ⊜

This should be the same as the final balance.

Note the CE key. If you press the wrong number just press (CE) then press the right number. If you use (CE) you don't have to start again, but if you have pressed a sign (+ or x or =) the (CE) will not work. Try it and see !

Date		In ⊕	Out ⊖	Balance ⊜
5.7.81.	Brt fwd	————	————>	-59.70
6.7.81.	Petrol		21.50	.....
6.7.81.	Sales	65.13		.....
7.7.81.	Sales	71.24		.....
8.7.81.	Cargo		125.36	.....
	TOTALS	......	......	....

Calculators-K6.00 each,post free, from Numeracy Project,Box1864,Boroko.

PRACTICE for FIRST CALCULATOR COURSE.

UNIT 1

1. Check by working Backwards

38 75 1.24

Total ....

2. 1.32 29 1.74 95

Total ....

3. 2.37 4.29 7.34

Total ....

4. Check by using ⓧ instead of ⊕

36 36 36 36

Total ....

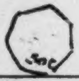
5. 12.28 12.28 12.28

Total ....

6. Check by finding the Change only

17 25

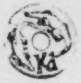
Total ....



Change ....

7. 45 16 24

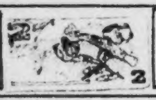
Total ....



Change ....

8. 35 0.83 0.49

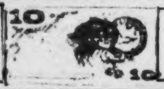
Total ....



Change ....

9. 7.24 1.39 0.65

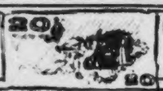
Total ....



Change ....

10. 9.58 3.07

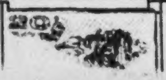
Total ....



Change ....

11. 12.58 0.95 2.09

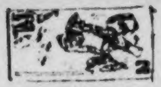
Total



Change

12. 38 38 38 38

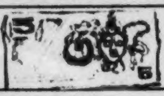
Total ......



Change ......

13. 59 59 59 59 59 59

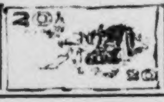
Total ......



Change ......

14. 2.74 2.74 2.74 2.74 2.74 2.74

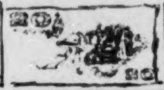
Total .....



Change ....

15. 1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15 1.15

Total .....



Change ....

16.

Date		In ⊕	Out ⊖	Balance ⊜
5.9.81.	Brt.fwd	→	→	124.60
6.9.81.	Sales	95.32		....
7.9.81.	Cargo		68.25	....
7.9.81.	Sales	83.90		....
8.9.81.	Freight		5.20	....
8.9.81.	Sales	102.31		....
9.9.81.	Sales	113.75		....
10.9.81.	Workboy		12.00	....
10.9.81.	Sales	142.78		....
11.9.81.	Bank		500.00	....
	TOTALS	....	....	....

Check by totalling as usual

If you press the wrong number, press CE and put in the right number.

Date		In ⊕	Out ⊖	Balance ⊜
1.5.	Brt.Fwd			0.00
2.5.	Patrick	1.20		.....
2.5.	Gertrude	3.20		.....
2.5.	Sedrick	5.00		.....
5.5.	Kaikai		4.70	.....
7.5.	Lucy	8.00		.....
8.5.	Stamps		2.30	.....
8.5.	Pen		0.64	.....
9.5.	Bernard	5.40		.....
9.5.	Melchior	4.30		.....
10.5.	George	22.90		.....
10.5.	Coke		9.65	.....
10.5.	Bank		30.00	.....
	TOTALS	.....	.....	.....

Answers: 1st Side: ① 165 : ② 1.26: ③ 1.53: ④ 1.73: ⑤ 9.39: ⑥ 3.84: ⑦ 12.31: ⑧ 16.28: ⑨ 99:
Ex.2: ① 87: ② 2.24: ③ 6.35: ④ 2.10:
Ex.3 ① 80:20: ② 1.69:31 ③ 1.73:3.27: ④ 1.92:3.08: ⑤ 2.28:2.72: ⑥ 9.48: 52:
Ex.4 ① 68.55: 56.55: 8.29: 1.79: 59.70: 112.51: 66.76: 59.70: ② 38.20: 103.33: 174.57: 49.21: 136.37: 146.86: 49.21:
2nd Side: ① 2.37: ② 4.30: ③ 14.00: ④ 1.44: ⑤ 36.84: ⑥ 42:8: ⑦ 85:15: ⑧ 1.67:33: ⑨ 9.28:72: ⑩ 12.65:7.35: ⑪ 19.83:17: ⑫ 1.52:48: ⑬ 2.95:2.05: ⑭ 16.44:3.56: ⑮ 10.35:9.65 ⑯ 538.06: 585.48:77.21: ⑰ 50.00:47.29:2.71:

Send K1.00 to the Numeracy Project Box 1864, Boroko. for a copy of the Business Arithmetic Workbook in 5 easy-to-understand units. It tells you how to use the calculator for everything to do with running a Trade Store.

DEPARTMENT OF COMMERCE NUMERACY PROJECT

CALCULATOR SKILLS PACK

FIRST VERSION: MAY 1982

CONTENTS

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2	4	Ex 3: Giving Change
4	7	Ex 4: Grand Totals, with the Memory
5	8	Ex 5: Totalling with x
6	3	Ex 6: + - and x
8	17	Ex 7: Totalling with x and +
10	11	Ex 8: Invoices and pricing items
12	14	Ex 9: Pricing goods in cartons, with and without freight
14	15	Ex 10: Cash Book
15	18	Ex 11: Metres and Centimetres
17	18	Ex 12: Pricing by Length
19	19	Ex 13: Plywood, Corrugated Iron etc
23	21	Ex 14: Time intervals
23	22	Ex 15: Pricing by time
24	23	Ex 16: Pricing by the batch
25	25	Ex 17: Miscellaneous Pricing

CALCULATOR - SKILLS PACK: EXERCISE SHEETS

EXERCISE 1: + and -

28 + 36 = ☐ checked ..

13 - 9 = ☐ .... checked

32 + 57 = ☐ ...

95 - 24 = ☐ ...

39 - 20 = ☐ ...

18 + 21 + 53 = ☐ ...

7) 37 + 45 - 60 = ☐ ...

8) 65 - 31 + 246 = ☐ ...

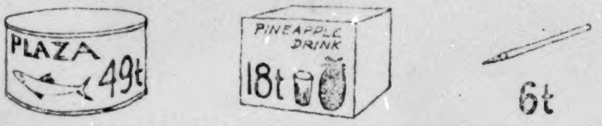
9) 162 + 53 + 183 + 64 = ☐ ...

10) 300 + 75 + 180 + 659 = ☐ ...

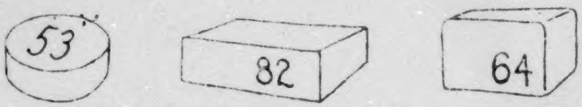
11) 374 + 913 + 2300 + 1452 + 76 = ☐ ...

12) 4000 + 2156 + 7180 + 9132 + 6154 = ☐ ...

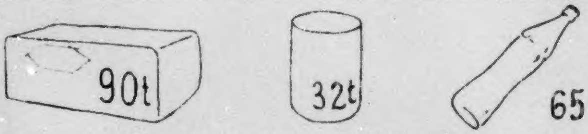
EXERCISE 2: Totalling Money


PLAZA
49t
PINEAPPLE DRINK
18t
6t

TOTAL ☐ .... checked

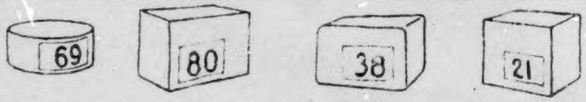


TOTAL ☐ ....

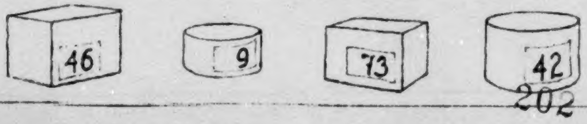


TOTAL ☐ ....

TOTAL ☐ ....



TOTAL ☐ ....



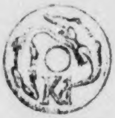
TOTAL ☐ ....

Ex 2 (cont.) DO NOT USE THE DECIMAL POINT KEY

1.25	- 6.15			TOTAL ....
1.86	32t	19t		TOTAL ....
5.00	2.64	9.00		TOTAL ....
4.00	1.32	2.00		TOTAL ....
4.61	3.00	2.39		TOTAL ....
3.78	0.23	0.87		TOTAL ....
0.59	6.14	0.05		TOTAL ....
0.08	6.29	3.76		TOTAL ....
7.00	4.20	8.03	0.29	TOTAL ....
3.05	0.80	9.00	0.06	TOTAL ....

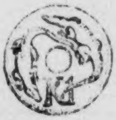
EXERCISE 3 : Giving Change

35t



CHANGE

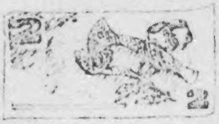
K0.75



CHANGE

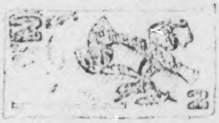
Ex 3 (cont.)

K1.53



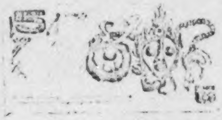
CHANGE

K0.28



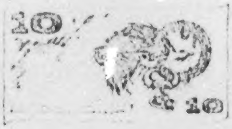
CHANGE

K3.24



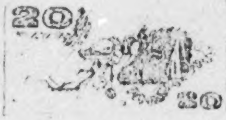
CHANGE

K9.29



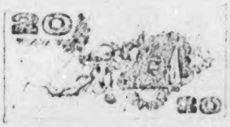
CHANGE

K13.68



CHANGE

K8.75

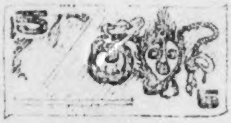


CHANGE

K1.32

K0.86

TOTAL

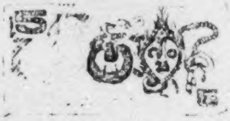


CHANGE

K2.25

K1.00

TOTAL



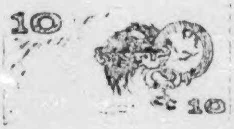
CHANGE

94t

K5.80

K2.11

TOTAL



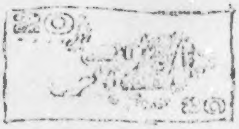
CHANGE

CSP

4

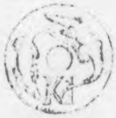
Ex 3 (cont)

2) K 3.72 K5.85
K7.43
TOTAL



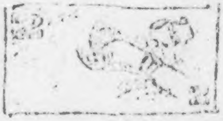
CHANGE

) 65t K0.05
K0.16
TOTAL



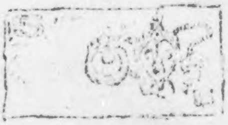
CHANGE

4) K1.31 25t
K0.09
TOTAL



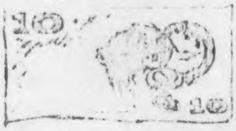
CHANGE

5) K2.00 8t
K1.95 68t
TOTAL



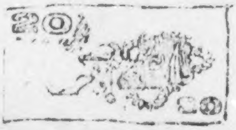
CHANGE

6) K3.10 K1.96 7t
K4.73 5t
TOTAL



CHANGE

7) K4.65 K6.47 K3.19
K0.58 K0.09
TOTAL



CHANGE

EXERCISE 4 Grand Totals with the Memory

		TOTALS
25	49	
73	36	

GRAND TOTALS

TOTAL check

2)

			TOTALS
65	3	45	
79	8	42	

4.71	7.54	
4.92	6.32	
3.13	8.41	

4)

13	58	125	
19	65	137	
17	43	121	

5

Ex 4 (Cont.)

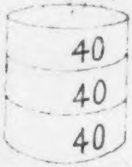
2.15	3.27	0.43	
1.74	3.45	0.91	
1.93	3.80	0.37	
2.02	4.12	0.55	

6)

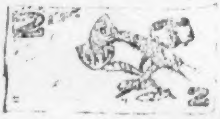
k	33.29	2.83	160.21	21.29	
k	57.18	2.46	135.05	32.17	
k	39.26	3.15	140.63	25.28	
k	45.15	2.84	155.60	30.64	
k					

Employee's Number	Units Produced					Employee's Totals
	Monday	Tuesday	Wednesday	Thursday	Friday	
1773	136	164	157	196	143	....
1774	187	212	216	193	184	....
1775	214	192	186	213	172	....
1776	193	198	167	164	179	....
1777	185	217	216	173	189	....
1778	163	184	197	174	158	....
1779	147	176	182	159	183	....
1780	181	183	169	168	196	....
Daily Totals						.....

EXERCISE 5 Totalling with X



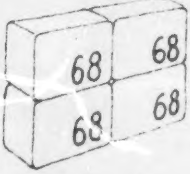
TOTAL



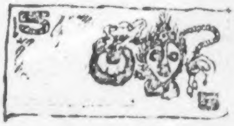
CHANGE

check

)

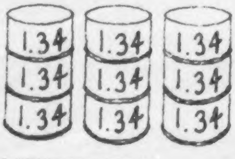


TOTAL

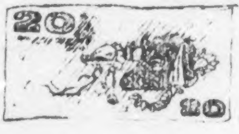


CHANGE

)

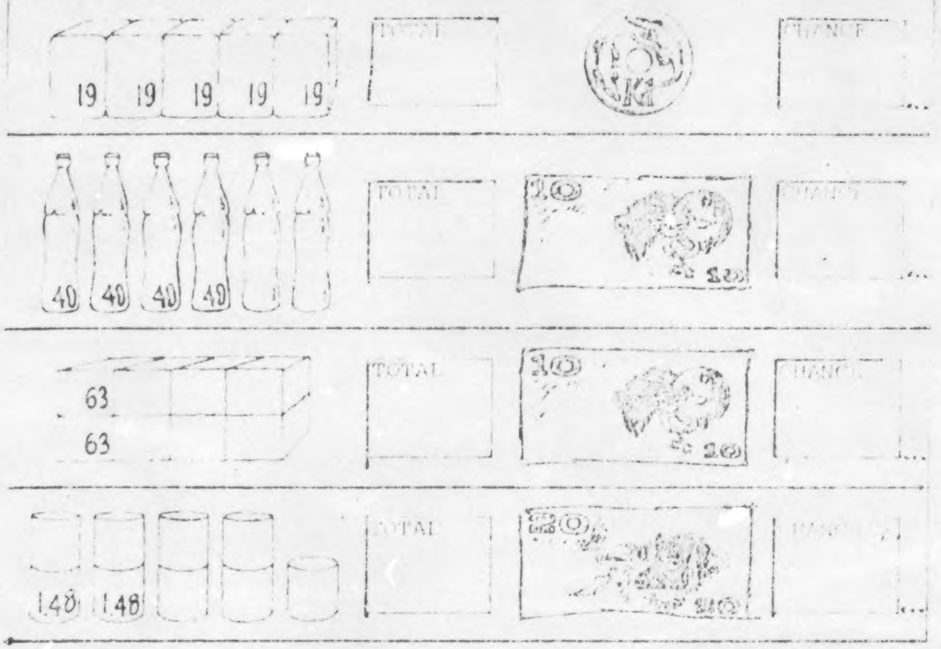

1.34
1.34
1.34
1.34
1.34
1.34
1.34
1.34
1.34

TOTAL



CHANGE

Ex 5 (cont.)


19
19
19
19
19
TOTAL
CHANGE
40
40
40
40
TOTAL
20
CHANGE
63
63
TOTAL
20
CHANGE
1.40
1.40
TOTAL
20
CHANGE

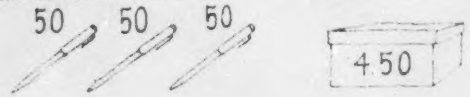
EXERCISE 6 : + – and ×

First write what you think the calculator will give you as the answer. Then use the calculator and write down what you get.

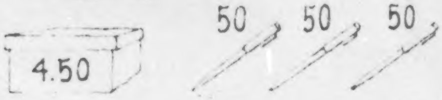
	YOU THINK	BY CALCULATOR
2 ⊕ 1 ⊗ 4 ⊜		
5 ⊕ 2 ⊗ 1 ⊜		
3 ⊗ 2 ⊕ 5 ⊜		
4 ⊗ 5 ⊕ 6 ⊜		
7 ⊕ 3 ⊗ 9 ⊜		
3 ⊕ 1 ⊗ 2 ⊕ 3 ⊜		
4 ⊕ 6 ⊗ 2 ⊕ 10 ⊜		
3 ⊕ 1 ⊗ 3 ⊖ 2 ⊜	207	

	YOU THINK	BY CALCULATOR
9) 1 ⊕ 5 ⊗ 10 ⊖ 10 ⊜		
6 ⊖ 2 ⊗ 2 ⨸ 2 ⊜		
3 ⊖ 1 ⊗ 5 ⊕ 4 ⊜		
2) 3 ⊗ 2 ⊕ 1 ⊗ 2 ⊜		
4 ⊕ 2 ⊗ 3 ⊖ 5 ⊜		
6 ⊗ 2 ⊖ 8 ⊗ 5 ⊜		
) 8 ⊖ 2 ⊗ 1 ⊜		
) 4 ⊗ 1 ⊕ 5 ⊜		
7) 7 ⊗ 1 ⊖ 3 ⊗ 1 ⊜		
18) 3 ⊕ 1 ⊗ 1 ⊖ 1 ⊜		
7) 8 ⊗ 1 ⊕ 1 ⊗ 1 ⊜		
0) 3 ⊗ 0 ⊕ 7 ⊜		
1) 0 ⊗ 5 ⊕ 4 ⊜		
2) 6 ⊗ 2 ⊕ 0 ⊜		
3) 5 ⊕ 3 ⊗ 0 ⊜		
4) 4 ⊖ 1 ⊕ 8 ⊗ 0 ⊜		
25) 5 ⊗ 1 ⊖ 3 ⊕ 0 ⊜	208	

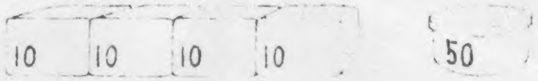
EXERCISE 7: Totalling with x and +



TOTAL ....



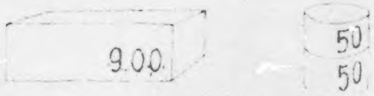
TOTAL ....


10
10
10
10
50

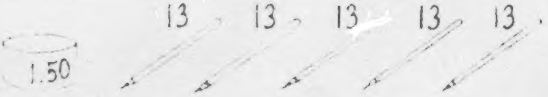
TOTAL ....

TOTAL ....

TOTAL

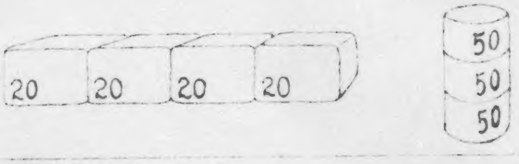


TOTAL


1.50
13
13
13
13
13

TOTAL

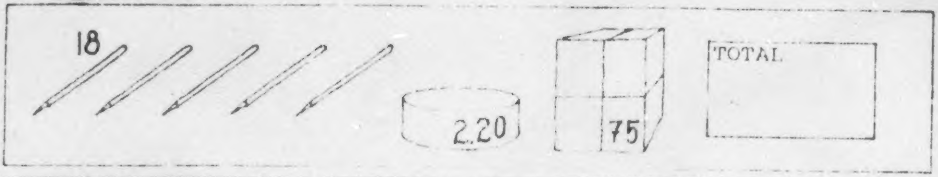
TOTAL


20
20
20
20
50
50
50

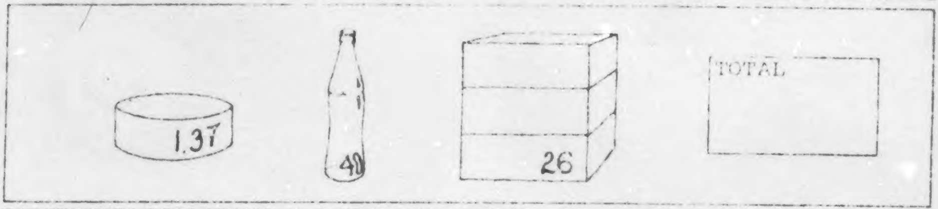
TOTAL

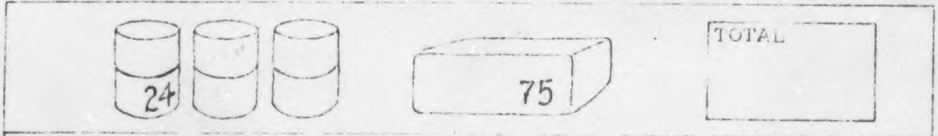
Ex 7 (cont)

10)

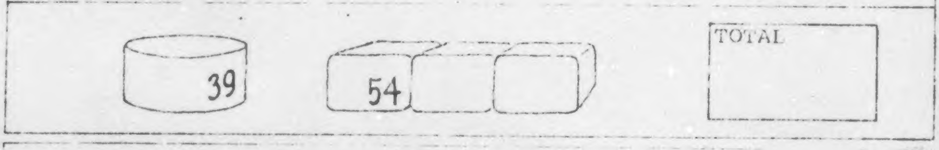

18
2.20
75
TOTAL

)

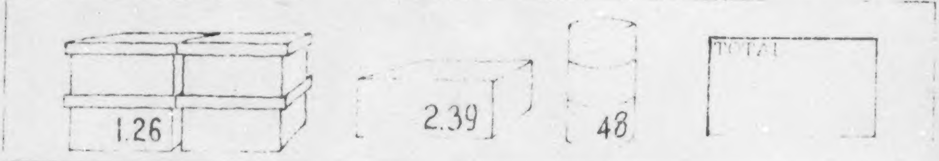

1.37
40
26
TOTAL

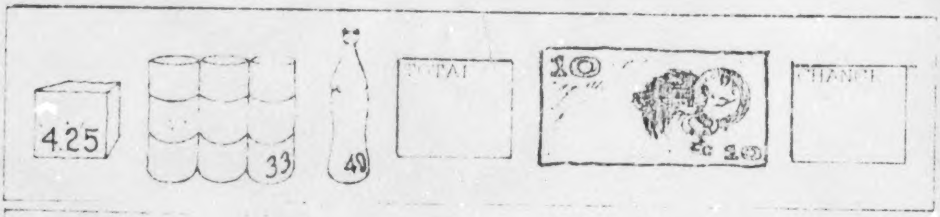

24
75
TOTAL

3)

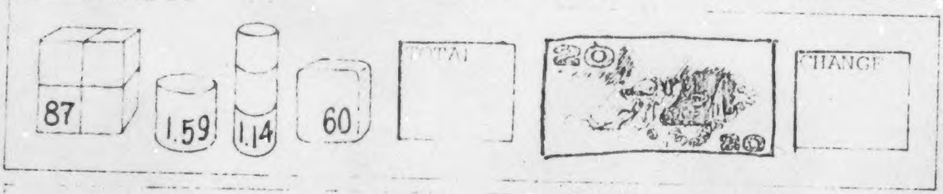

39
54
TOTAL

)

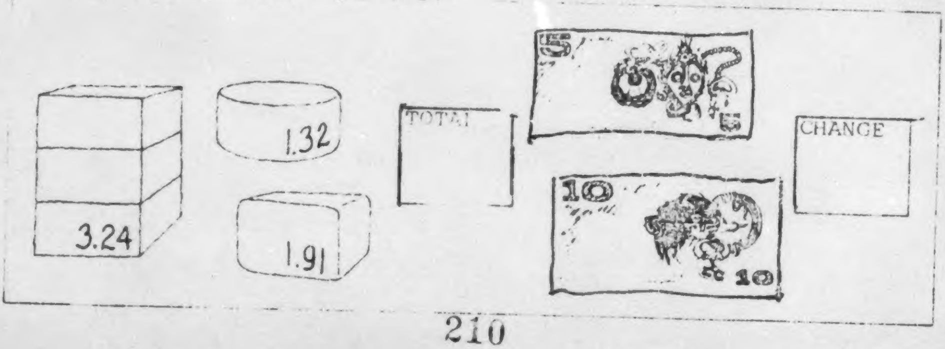

1.26
2.39
48
TOTAL


4.25
33
40
TOTAL
10
£10
CHANGE

)

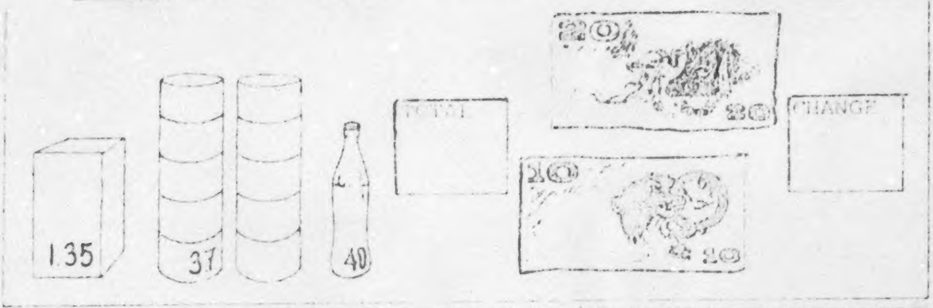

87
1.59
1.14
60
TOTAL
20
£20
CHANGE

)

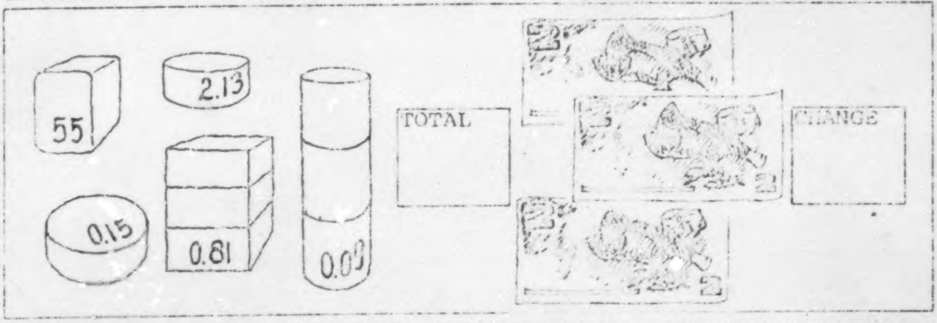

3.24
1.32
1.91
TOTAL
5
£5
10
£10
CHANGE

Ex 7 (cont)

18)


1.35
37
40
TOTAL
CHANGE

9)


55
2.13
0.15
0.81
0.09
TOTAL
CHANGE

EXERCISE 8: Invoices and Pricing Items

INVOICE			OK?	S.P.
5 Exercise Books	11t	2.75	..	....
0 Pads	9t	1.80	..	....
4 Scissors	12t	2.88	..	....
		K 7.43	..	

INVOICE			OK?	S.P.
6 Metre Rules	2.20	13.20	..	......
Chalkboards	85t	5.46	..	....
ttles Gum	49t	2.47	..	....
		K 21.13	..	

Ex 8 (cont.)

	INVOICE			OK?	S.P.
50	Pens	5t	2.50	..	.....
60	Pencils	8t	4.80	..	.....
12	Erasers	9t	8.10	..	.....
			15.40	..	

	INVOICE			OK?	S.P.
9	boxes Paper clips	15t	1.35	..	.....
12	large Bulldog clips	13t	1.56	..	.....
24	small Bulldog clips	6t	1.44	..	.....
1	Clipboard	68t	0.68	..	.....
			5.03	..	

	INVOICE			OK?	S.P.
4	Letter opener	27t	1.08	..	.....
1	Desk blotter	K1.23	1.23	..	.....
8	Wooden rulers	31t	2.48	..	.....
3	Staplers	K1.89	5.67	..	.....
15	Scribbling pads	29t	4.35	..	.....
			24.81	..	

SP

Ex 8 (cont.)

INVOICE			OK?	S.P.
30 sheets Blotting paper	0.06	1.80	..	.....
1 Dictionary	5.95	5.95	..	.....
6 Calculators	5.50	33.00	..	.....
2 bottles Red ink	1.09	2.81	..	.....
1 Cash box	11.27	11.27	..	.....
		54.83	..	

XERCISE 9: Pricing goods in Cartons, with & without Freight

INVOICE No. 53271
Bulkstoa Pty Ltd, Lae
O: Numeracy Project, Laloki 20.5.81

Freight: 50t/carton

			Without freight				With freight	
			OK	UCP		SP	UCP	SP
Fish in oil 48 x 15oz	14.30	57.20	✓.	29t.	10%	33t.	.....	.....
C/Beef 24 x 340g	22.15	66.45	..	....	10%	....	.....	.....
Tea 120 x 125g	33.00	33.00	..	....	10%	....	......	.....
heezpops 72 pkts	6.10	12.20	..	....	60%	....	......	.....
		168.85	..					

INVOICE No. 53391
Bulkstoa Pty Ltd, Lae
: Numeracy Project, Laloki 27.5.81

Freight: K18.50 for 12 cartons
= K ...... per carton.

			Without freight				With freight	
			OK	UCP		SP	UCP	SP
eal milk 48 x 15oz	9.47	47.35	..	....	10%	....	.....	.....
ne o'Clean 12 x 750ml	6.60	13.20	..	....	30%	....	.....	.....
asoning 28 x 125ml	13.58	54.32	..	....	30%	....	.....	.....
ao Biscuit 20 x 255g	10.70	10.70	..	....	50%	....	.....	.....
		125.57	..					

Ex 9 (cont.)

INVOICE No. 65132
Bulkstoa Pty Ltd, Lae
D TO: Numeracy Project, Laloki 28.6.81

Freight: 50t per carton
BUT ALL the SPOONS
were in ONE CARTON.

			Without freight				With freigh	
			OK	UCP		SP	UCP	S
3bale S.R.Flour 6 x 2kg	7.30	21.90	..	....	10%	....	......	....
4ctn Fish, canned 48 x 454g	14.80	59.20	..	....	10%	....	....-	....
Table spoon (10 in pkt)	1.60	4.80	..	....	80%	....	.....	....
1ctn Omo 48 x 225g	22.92	22.92	..	....	12½%	....	......	....
		118.82	..					

INVOICE No. 66809
Bulkstoa Pty Ltd, Lae
D TO: Numeracy Project, Laloki 5.8.81

Freight: K5.90 for 10 cartons
BUT ALL the RUBBER BALLS
were in ONE CARTON

			Without Freight				With Freig	
			OK	UCP		SP	UCP	SP
2bundle Rubber balls 20's	11.00	22.00	..	....	80%	....	.....	....
1 doz Meri blouse	42.00	42.00	..	....	60%	....	.....	....
3 ctn Nescafe Expresso 24's	20.50	81.50	..	....	12½%	....	....	....
4ctn Baked bean 24 x 225g	6.03	24.12	..	....	30%	....	....	....
1 ctn Omo 12 x 750g	26.05	26.05	..	....	12½%	....	.....	....
		195.67	..					

lt

INVOICE No. 53487
Bulkstoa Pty Ltd, Lae
m SOLD TO: Numeracy Project, Laloki 3.6.81

Freight: 15toea / kg.

				Without freight				With freigh	
				OK	UCP		SP	UCP	SP
13,	2 ctn Dripping 24 x 395g	12.68	25.36	..	....	30%	....	.....	.....
12g	3 ctn Salt 12 x 750g	5.34	16.02	..	....	30%	....	......	.....
9kg	1 ctn P/butter 24 x 200g	13.19	13.19	..	....	30%	....	.....	.....
11kg	2 ctn Evaporated milk 48's	8.37	16.74	..	....	10%	....	.....	.....
13kg	4 doz Football boots	29.60	118.40	..	....	80%	....	.....	.....
			189.71	..					

csp

EXERCISE 10: Cash Book

DATE	ITEM	IN (+)	OUT (−)	BALANCE (=)
7.5.81	Balance at first →			21.90
8.5.81	Sales	35.42		......
9.5.81	Cargo		33.05	......
9.5.81	Sales	22.13		......
10.5.81	Sales	23.84		......
11.5.81	Wages		5.00	......
11.5.81	Freight		1.20	......
11.5.81	Sales	30.80		......
12.5.81	Bank		50.00	......
12.5.81	Totals/Final Balance	......	......	......

ATE	ITEM	IN (+)	OUT (−)	BALANCE (=)
.5.81	Balance brought forward →			44.84
.5.81	Sales	35.62		......
.5.81	Wages		10.00	......
.5.81	Cargo		57.69	......
.5.81	Sales	29.53		......
.5.81	Sales	28.04		......
.5.81	Bank		60.00	......
.5.81	Totals/Final Balance	......	......	......

DATE	ITEM	IN (+)	OUT (−)	BALANCE (=)
15.5.81	Balance brought forward →			......
15.5.81	Sales	95.24		......
16.5.81	Sales	82.30		......
17.5.81	Sales	23.50		......
17.5.81	Freight		14.10	......
17.5.81	Cargo		68.35	......
17.5.81	Sales	105.63		......
18.5.81	Bank		200.00	......
18.5.81	Totals/Final Balance	......	......	......

Ex 10 (Cont) Make up your own!

4)

DATE	ITEM	IN (+)	OUT (−)	BALANCE (=)
	Balance brought forward	→	→	

EXERCISE 11: Metres and Centimetres

What are the total lengths of:

1) 1.37 m and 1·84 m ....
2) 3.94 m and 65 cm ......
3) 2.10 m, 1.75m and 3.64 m ....
4) 3·72 m ,1.46m and 59 cm ....
5) 5.00 m, 7.32m, 4.00m and 67cm ......
6) 8m ; 1.42m, 5m ....
7) 3m , 2.50m, 65cm ....
8) 14.60m, 25.90m, 82m ....
) 3.52m, 29 cm, 4m ......
) 82cm, 4.37m, 5m, 9m ......

) 3·21m is cut from a 5.70m length: how much is left? ....
) 4.75m is cut from a 9.12m length: how much is left? ......
) 5.64m is cut from an 8m length: how much is left? .....
) 31cm is cut from a 2.85m length: how much is left? ....
) 72cm is cut from a 3m length: how much is left? .....

SP

Ex 11 (cont.)

16) How much longer is 3.24m than 1.05m? .....
17) - - - - 5m than 2.39m? .....
18) How much shorter is 2.95m than 4.17m? .....
19) - - - - 3.74m than 9m? .....
20) - - - - 28cm than 3m? .....

What is the total length of
21) 3 bars each 1.24m long? ......
22) 7 rods each 83cm long? ......
23) 5 pieces of cotton each 2.10m long? .....
24) 6 pieces of wood each 91cm long? .....
25) 12 pieces of wood each 1.32m long? .....

---

26) 2 pieces 1.74m and 85cm are cut from a length of 2.84m. What length is left? .....

27) 3 pieces 67cm, 39cm and 48cm are cut from a piece 2.15m long: how much is left? ......

28) 4 pieces each 28cm long are cut from a piece 1.95m long: how much is left? ......

29) 5 pieces of wire each 1.68m long are cut from a piece 18.12m long. How much is left? ......

30) 25 pieces of string each 18cm long are cut from a piece 13m long. How much is left?

Find the total lengths of:

) 4 pieces 1.70m .....
9 pieces 2.15m .....
33 pieces 46cm ......
Total ....

32) 8 pieces 32cm ......
16 pieces 1.05m .....
4 pieces 1.83m ......
Total ....

33) 12 of 83cm ....
15 of 1.26m ....
Total ....

) 6 pieces 13cm ....
25 pieces 7cm .....
1 piece 93cm ......
Total ......

35) 8 pieces 2.05m ......
4 pieces 36cm .....
3 pieces 4m ......
Total .....

EXERCISE 12: Pricing by Length

I have four pieces of material:

Piece Ⓐ is 1.39m long; Ⓑ is 0.85m long; Ⓒ is 4m; Ⓓ is 93cm.

1) Which is longest A, B, C or D? ......
2) Which is shortest A, B, C or D? ......
3) How much longer is the longest than the shortest? .....
4) What is the total length of all four pieces? ......
5) Which pieces could used to make a blouse that needed 1.25m? A, B, C, D? ....
6) A child's skirt needs 45cm: how much for 7 skirts? ......
7) How much would be left from piece Ⓒ after using part of it to make these 7 skirts? ....

A "bolt" of material is 30m to 40m long: if you are buying one, ask first how long it is.

)A bolt cost K28.75, its length was 35m: COST PER METRE = ...
)Bolt cost K36.10, length 38m: COST PER METRE ....
)Bolt cost K32.00, length 40m: COST PER METRE ....
11) Bolt cost K38.40, length 36m: COST PER METRE ....
12) A 6m length cost K5.90: COST PER METRE ....
13) A length of 14m cost K21.34: COST PER METRE ....
14) Bolt, length 33 m cost K29.75: COST PER METRE .....
15) Bolt, cost K24.60, length 30m: COST PER METRE ......

---

16) Bolt, 34m long costs K29.50: what is the cost per metre? ......
17) What would 5m of this material cost? .....
18) What would 2.75m of it cost? ....
19) What would 1.50m of it cost? ....
20) What would 0.30m of it cost? ......
21) What would 40cm of it cost? ......

SP

Ex 12 (cont.)

22) Dress takes 3m. Cost per metre is K1.05: Cost of Material ....

23) Dress takes 1.50m. Cost per metre is 63t: Cost of Material ....

1) Skirt takes 75cm. Cost per metre is K1.37: Cost of Material......

Skirt takes 1.25m. Cost per metre is K1.10: Cost of Material ....

Dress 1.85m. Cost per metre is 83t: Cost of Material ....

Child's blouse 55cm. Cost per metre is K1.12: Cost of Material ......

Child's dress 95cm. Cost per metre is K1.30: Cost of Material ....

9) Dress 2.25m. Cost per metre is 76t: Cost of Material ....

Dress 2m. Cost per metre is 90t. Extras: 5 buttons costing 80
Cost of Making (including profit) K2.00. Selling Price ....

Skirt 1.10m. Cost per metre is 85t. Extras: Zip costing K1.20
Cost of Making K1.90: Selling Price ....

Dress 2.30m. Cost per metre is K1.14. Extras:
3m of bias binding at 55t per metre & Cost of Extras......
Cost of Making K2.50. Selling Price ....

) Blouse 0.85m. Cost per Metre 94t. Extras: 10 buttons,
a card of 5 buttons costs 26t so Cost of Extras........
Cost of Making K2.00. Selling Price ....

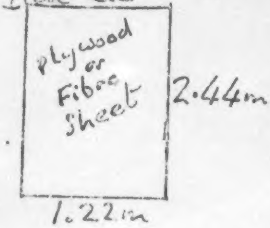
) Skirt 75cm. Cost per Metre K1.05. Extras: 60cm of
elastic costing 35t per metre, so Cost of Extras ....
Cost of Making K1.00. Selling Price ....

-) Mattress Cover 5m of unbleached calico costing
65t per metre. No extras. Cost of Making K1.00.
Selling Price. . . . . .

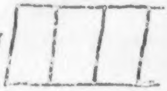
36) 6 curtains, each 2.45m long. Cost per Metre K1.15.
Extras: 6m of net costing 36t per metre. 2 reels of cotton
-3P] at 90t each: Cost of Extras:......Cost of Making K2.50 S.P. ....

EXERCISE 13: Plywood, Corrugated Iron etc

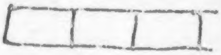
Plywood and Fibro panels used to be "4ft by 8ft": they are now 1.22m by 2.44m.



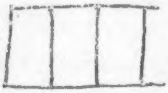
1) A wall is made up of 9 plywood sheets like this What is the length of the wall? ....



2) A fence is made of plywood sheets like this: What length will they reach? ....



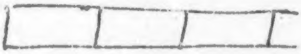
3) The ceiling is made of 7 plywood sheets: and an extra 85cm strip at the end. What is the length of the room? ......



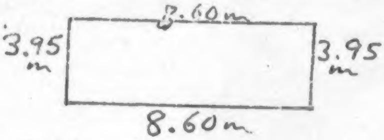
4) A house is 13.30m long. How many Fibro sheets like this will be needed for one wall? ....

5) Another house is 8.75m long. How many Fibro sheets for this one? ......

6) A barrier is to be made of plywood:



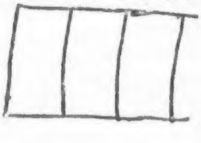
It is to go all round a hut 8.60m long and 3.95m wide :-



a) What is the distance all round the hut? ....

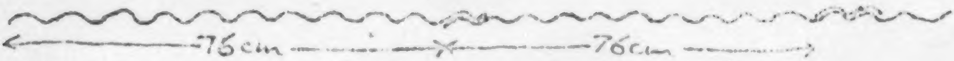
b) How many plywood sheets will be needed? .....

c) If the sheets were on end like this how many would be needed? ....



CSP

Ex 13 (cont.)



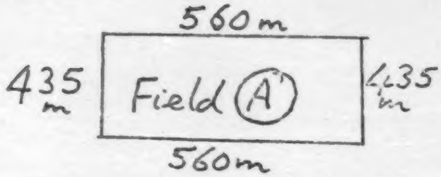
Corrugated iron sheet are 86 cm wide but allowing 10 cm for an overlap, we calculate as if they were 76 cm wide.

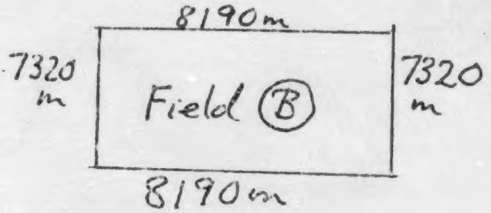
7) A roof is just covered by 15 iron sheets: how long is it? ....

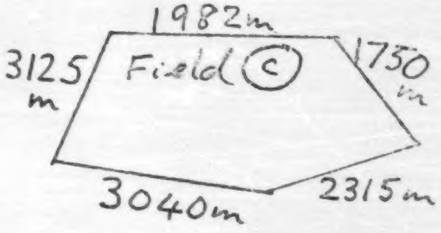
8) A hut is 11.85m long: how many iron sheets will be needed to cover it? ....

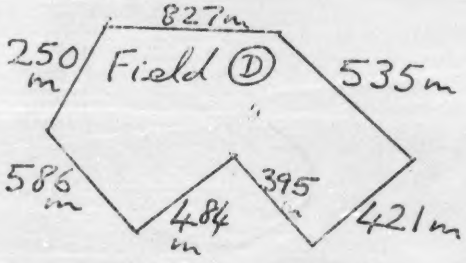
9) A club-building is 17m long. How many iron sheets to roof it? ......

10) A shed is 4.60m long: how many iron sheets to roof it? ......


560m
435 m
Field (A)
435 m
560m


8190m
7320 m
Field (B)
7320 m
8190m


1982m
3125 m
Field (C)
1750 m
3040m
2315m


827m
250 m
Field (D)
535m
586 m
484 m
395 m
421m

The "Perimeter" is the distance all round a field: to find the Perimeter you add all the lengths of the sides together.

Perimeter of Field (A) is ...... ; Perimeter of Field (B) is ....
Perimeter of Field (C) is .... ; Perimeter of Field (D) is ....

Small posts (or iron "pickets") are needed every 4 m, so you can find the number you need by dividing the Perimeter by 4. But you should get some spare ones so add 5% for this. So the "FORMULA" for the calculator is:

(Perimeter) (÷) 4 (+) 5 (%)

Number of small posts for (A) ...... ; Number of small posts for (B) ......
Number of small posts for (C) ...... ; Number of small posts for (D) ......

Big "strainer" posts are needed every 100 m and also at the corners. You will have to count the corners on the pictures above So the FORMULA is:

(Perimeter) (÷) 100 (+) (number of corners) (=)

(You must "round up" to make sure you have enough)

Number of big posts for (A) .... ; Number of big posts for (B) .....
?Number of big posts for .. ???. ; Number of big posts for (D) .....

Ex 13 (cont.)

14) If you need 4 strands of wire for the fence you must multiply the Perimeter by 4 to find the length of wire needed. If the wire comes in 400 m rolls you must then divide by 400 to find the number of rolls needed. Add 5% for safety and "round up". So the FORMULA is:

(Perimeter) (×) 4 (÷) 400 (+) 5 (%) and round up.

Number of rolls of wire for Ⓐ . . . . ; Number of rolls for Ⓑ . . . . . .
Number of rolls of wire for Ⓒ . . . . . ; Number of rolls for Ⓓ . . . . .

1) If you have 4 strands of wire you will need 4 staples for each small post AND 4 for each big post. Add 5% for safety. So the FORMULA is:

(Number of small posts) (+) (Number of big posts) (×) 4 (+) 5 (%)

Number of staples for Ⓐ . . . . . . ; Number of staples for Ⓑ . . . . . .
Number of staples for Ⓒ . . . . . . ; Number of staples for Ⓓ . . . . . .

16) Staples are sold in boxes of 50 kg or 25 kg. To find the Weight of staples you need you must divide the number you want by the number you get for 1 kg. (To find this you can weigh out 1 kg and count them) To find the number of boxes you must divide the weight you need by the weight in 1 box. So the FORMULA is:

(Number of staples needed) (÷) (Number of staples in 1 kg) (÷) (Number of kg in 1 box) (=) and round up.

If each box contains 25 kg and you get 550 staples to the kg.
Number of boxes needed for Ⓐ . 223 . . ; Number of boxes for Ⓑ . . . . . .
Number of boxes needed for Ⓒ . . . . . ; Number of boxes needed for Ⓓ . . . . .

EXERCISE 14: Time Intervals

How many hours from one time to the other? Use $\frac{1}{4}$ hour for 15 minutes, $\frac{1}{2}$ hour for 30 minutes, $\frac{3}{4}$ hour for 45min

) 9 a.m. to 11.15 a.m. ......
10a.m. to 12.30p.m. ....
8a.m. to 10.45a.m ....
2 p.m to 5.30 p.m ....
4p.m. to 9 p.m .. ...
6) 1 p.m. to 5.15 p.m ......
3 p.m to 4.45 p.m ......
5 p.m. to 10.30 p.m. .....
8 a.m to 5 p.m. .....
10 a.m to 1.30 p.m. .....
9 a.m to 2.15 p.m. .....
) 8 a.m to 3.45 p.m .....
13) 11 a.m. to 4.30 p.m. ......
14) 12 noon to 2.45 p.m .....
15) 7.30 a.m. to 11 a.m ......
16) 6.15 p.m to 9 p.m. ......
17) 4.45 p.m. to 8 p.m. ......
18) 7.15 a.m. to 12 noon .....
19) 8.30 a.m. to 11 a.m. .....
20) 9.15 a.m to 11 a.m ......
21) 11.30 a.m to 2.30 p.m. .....
22) 10.45 a.m to 3.45 p.m ....
23) 8.15 a.m to 10.45 p.m ....
24) 11.30 a.m to 5.15 p.m .....

EXERCISE 15: Pricing by time

Find the charges for:

) 2 hours at 25t per hour .....
) 4 hours at 30t per hour .....
) $7\frac{1}{2}$ hours at 50t per hour ....
) $10\frac{1}{4}$ hours at 60t per hour ....
) $12\frac{3}{4}$ hours at 80t per hour ....
) From 8 a.m to 11.30 a.m at 40t per hour .....
) From 1p.m. to 3.45p.m. at 50t per hour .....
) From 11a.m. to 7.15p.m. at 30t per hour .....
) From 10a.m to 2.30p.m. at 70t per hour .....
) From 4.30p.m. to 7 p.m. at 60t per hour ....
) From 9.15a.m. to 2 p.m at 50t per hour .....
2) From 11.30 am to 3p.m at 20t per hour ...

13) To make a bilum Martha bought 6 lots of thread at 15t each lot and spent 13 hours making it at 40t per hour. Price ....

Ex 15 (cont)

14) To make a necklace Paul bought a cupful of beads for 50t which was enough for 8 necklaces, and a lot of nylon thread which cost K1.50 and was enough for 40 necklaces. It took him 3 hours to make one necklace, at 30t per hour.
Price for one necklace . . . . .

15) It took Mary 4 hours travelling, for which she charged 30t per hour, and PMV fares of K2.50 to buy a bolt of material which was enough for 15 dresses. She spent 3 hours at 60t per hour to make one dress and buttons for it cost K0.80.
Price for one dress . . . . . .

EXERCISE 16: Pricing by the Batch

1) MEAT BALLS. Ingredients for 1 batch were:
2 kg meat costing K2.55 per kg. COST PER BATCH.....
A quarter of a bag of onions costing 70t a bag. COST PER BATCH....
1 litre of oil costs K2.70 and lasts for 50 batches: COST PER BATCH.....
TOTAL COST OF BATCH:.......
Each batch made 18 meat balls: UNIT COST PRICE....
Add 80% for SUGGESTED SELLING PRICE ....
Round this off to a CONVENIENT SELLING PRICE......

) TAPIOC PARCELS. Ingredients for 1 batch were:
Tapioc root from market costing 80t: COST PER BATCH......
2 tins of meat costing 65t each: COST PER BATCH......
A quarter of a packet of salt costing 18t a packet: COST PER BATCH....
TOTAL COST OF BATCH: . . . . .
Each batch made 24 parcels: UNIT COST PRICE....
Add 80% for SUGGESTED SELLING PRICE .... CONVENIENT S.P.....

Ex 16 (cont.)

3) COCONUT BISCUITS. Ingredients for a batch of 48 big ones
1 coconut for 20t: COST PER BATCH .....
Half of a 1 kg packet of S.R. Flour at 40t a packet:
COST PER BATCH ...

1 egg: A packet of 10 eggs cost K1.30: COST PER BATCH ....
Quarter of a 1 kg packet of Sugar at K1.05 a pkt. COST PER BATCH...
Half of a 226g packet of butter costing 28t a pkt: COST PER BATCH...
Half a bundle of firewood costing K1.00 per bundle. COST PER BATCH...
TOTAL COST OF BATCH ..... UNIT COST PRICE ....
Add 80% SUGGESTED SELLING PRICE ...... CONVENIENT S.P. .....

4) SCONES. Ingredients for a batch of 24 scones:
Half a 10kg bag of flour costing K5.61: COST PER BATCH: ......
ome baking powder: a packet costing 80t would
last for 20 batches: COST PER BATCH .....
Some "yellow egg" colouring: a packet costing K1.05
would last for 30 batches: COST PER BATCH .....
A little salt: a packet costing 17 toea would last
for 20 batches. COST PER BATCH .....
Cooking Oil: 2 litres costing K4.05 is enough to
fry 80 batches. COST PER BATCH .....
We pay a cook K24.00 per week. He makes
about 570 batches in a week. COST PER BATCH....
We spend K45.50 on a gas cylinder for cooking;
it lasts a fortnight (we cook 57 batches a week) COST PER BATCH.
TOTAL COST OF BATCH...... UNIT COST PRICE....
Add 80%: SUGGESTED SELLING PRICE..... CONVENIENT S.P. ...

EXERCISE 17: Miscellaneous Pricing

) Eggs are sold at K1.70 per dozen. How much for:
(a) 2 dozen.... (b) 5 dozen ..... (c) 10 dozen ....
(d) ½ dozen .... (e) 1 egg ..... (f) 7 eggs.....

Ex17 (Cont.)

) Four week old chicks cost K1.50 each. ..

) How many will I get for K20.00? . . . .

b) How much will I actually have to pay for this number of chicks at K1.50 each? . . . .

(c) How much change will I get from K20.00 . . . .

If the price goes up to K1.70, how many will I now get for K20.00? . . . . .

e) How much will these actually cost? . . . . .

f) How much change will I get? . . . . .

3) I bought 9 calculators from Store A for K169.65. In Store B I bought 5 calculators for K103.50.

(a) Which store charged most per calculator? . . . .

(b) How much did it charge per calculator? . . . .

(c) If I had bought 14 calculators at K6.00 each instead of all the calculators above, how much would I have saved? . . . . .

4) Printing costs are worked out like this: 1.5t per sheet of paper and 40t per plate. Then add 25% for other expenses.

(a) How much is charged for 3500 copies of 3 sheets printed both sides? (This will need 6 plates) . . . .

b) Also find the charge for 950 copies of 4 sheets printed both sides and 1 sheet printed 1 side . . . . .

5) Duplicating charges are worked out like this: K2.00 per 500 sheets (Work out the price of 1 sheet and multiply by the number you need.) Also 50t per stencil and add 25%.

Find the charges for:

(a) 3500 copies of 3 sheets printed both sides . . . . .

(b) 950 copies of 4 sheets printed both sides and 1 printed 1 side

Ex 17. (Cont.)

6) We bought the following second hand clothes: the prices include freight from Australia etc.

Qty	Item	Unit Cost Price	Total	S.P. each for 30% markup
650	Skirts	41t	.....	......
1300	Summer Blouses	24t	.....	......
1000	Lightweight Jumpers	23t	.....	.....
200	pairs Ladies shoes	36t	.....	......,
300	hand bags	40t	......	.....
400	Paperback Books	12t	......	......
500	Men's Jackets	60t	.....	......
650	Men's Trousers	40t	....	.....
	TOTAL COST OF ORDER		....	

(a) Work out the total cost of the order, using the memory.

(b) Find the S.P. for each item, given a 30% markup (Round up to the toea above)

(c) Use the memory to work out the Total amount received if all goods are sold at the prices you have found ....

(d) Find the total profit on the order if all goods are sold ......

7) Fares to Lae and back cost K12.00. When I am there I can buy 35 coconuts for 20t each and bring them all back with me. What must I sell each coconut for if I am just to cover the cost of the trip? .....

8) (a) Air freight costs 57t per kg plus an extra basic charge of K4.00: find the total cost of sending 26 kg .... . .

Ex 17 (cont.)

(b) If the freight is 89t per kg plus K4.00 basic charge what is the freight for 3 kg? . . . . .

(c) If the freight is K1.09 per kg plus K4.00 basic charge what is the freight for 17 kg? . . . . .

9) Children (between 2 and 12 years of age) are charged half fares. Students are charged $\frac{1}{4}$ fares. If the fare from Moresby to Mendi is K102.00 find the cost of:

(a) 3 whole and one half fare . . . . .
(b) 2 whole and one quarter fare . . . . .
(c) 3 whole and 2 half fares . . . . .
(d) 5 whole and 3 quarter fares . . . . .
(e) 1 whole, 1 half and 1 quarter fares . . . .
(f) 2 whole and 2 half fares . . . . .
(g) 3 quarter fares . . . . .
(h) 7 half fares . . . . .

If the single fare is K65.00 what is the cost of

(i) 1 whole and 1 half fare . . . . .
(j) 3 whole and 2 half fares . . . .

10) Sometimes (eg. in contracts) freight charges are in decimals of a toea.

(a) Freight is 7.5t per kg: Charge for 7325kg: . . . . . .
(b) Freight is 8.2t per kg: Charge for 50 000kg: . . . . .
(c) Freight is 9.5t per kg, Charge for 1 tonne (= 1000kg) . . . . .

11) A 25kg bag of rice costs K9.29. You are going to sell it in cupfuls: 26 cupfuls of rice weigh 3 kg.

(a) How many lots of 3kg can you get out of 25kg? . . . . .
(b) How many cupfuls can you get out of 25kg? (Use what was on your calculator for (a))
(c) What is the Unit Cost Price for 1 cupful . . . . .

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